AHRQ Healthcare Horizon Scanning System – Potential High Impact Interventions Report

Priority Area 02: Cancer

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Statement of Funding and Purpose

This report incorporates data collected during implementation of the Agency for Healthcare Research and Quality (AHRQ) Healthcare Horizon Scanning System by ECRI Institute under contract to AHRQ, Rockville, MD (Contract No. HHSA290201000006C). The findings and conclusions in this document are those of the authors, who are responsible for its content, and do not necessarily represent the views of AHRQ. No statement in this report should be construed as an official position of AHRQ or of the U.S. Department of Health and Human Services.

This report's content should not be construed as either endorsements or rejections of specific interventions. As topics are entered into the System, individual topic profiles are developed for technologies and programs that appear to be close to diffusion into practice in the United States. Those reports are sent to various experts with clinical, health systems, health administration, and/or research backgrounds for comment and opinions about potential for impact. The comments and opinions received are then considered and synthesized by ECRI Institute to identify interventions that experts deemed, through the comment process, to have potential for high impact. Please see the methods section for more details about this process. This report is produced twice annually and topics included may change depending on expert comments received on interventions issued for comment during the preceding 6 months.

A representative from AHRQ served as a Contracting Officer's Technical Representative and provided input during the implementation of the horizon scanning system. AHRQ did not directly participate in horizon scanning, assessing the leads for topics, or providing opinions regarding potential impact of interventions.

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Financial Disclosure Statement

None of the individuals compiling this information has any affiliations or financial involvement that conflicts with the material presented in this report.

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Preface

The purpose of the AHRQ Healthcare Horizon Scanning System is to conduct horizon scanning of emerging health care technologies and innovations to better inform patient-centered outcomes research investments at AHRQ through the Effective Health Care Program. The Healthcare Horizon Scanning System provides AHRQ a systematic process to identify and monitor emerging technologies and innovations in health care and to create an inventory of interventions that have the highest potential for impact on clinical care, the health care system, patient outcomes, and costs. It will also be a tool for the public to identify and find information on new health care technologies and interventions. Any investigator or funder of research will be able to use the AHRQ Healthcare Horizon Scanning System to select potential topics for research.

The health care technologies and innovations of interest for horizon scanning are those that have yet to diffuse into or become part of established health care practice. These health care interventions are still in the early stages of development or adoption, except in the case of new applications of already-diffused technologies. Consistent with the definitions of health care interventions provided by the Institute of Medicine and the Federal Coordinating Council for Comparative Effectiveness Research, AHRQ is interested in innovations in drugs and biologics, medical devices, screening and diagnostic tests, procedures, services and programs, and care delivery.

Horizon scanning involves two processes. The first is identifying and monitoring new and evolving health care interventions that are purported to or may hold potential to diagnose, treat, or otherwise manage a particular condition or to improve care delivery for a variety of conditions. The second is analyzing the relevant health care context in which these new and evolving interventions exist to understand their potential impact on clinical care, the health care system, patient outcomes, and costs. It is NOT the goal of the AHRQ Healthcare Horizon Scanning System to make predictions on the future use and costs of any health care technology. Rather, the reports will help to inform and guide the planning and prioritization of research resources.

We welcome comments on this Potential High Impact report. Send comments by mail to the Task Order Officer named in this report to: Agency for Healthcare Research and Quality, 540 Gaither Road, Rockville, MD 20850, or by e-mail to effectivehealthcare@ahrq.hhs.gov.

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Contents

Figures

Executive Summary

Background

Horizon scanning is an activity undertaken to identify technological and system innovations that could have important impacts or bring about paradigm shifts. In the health care sector, horizon scanning pertains to identifying new (and new uses of existing) pharmaceuticals, medical devices, diagnostic tests and procedures, therapeutic interventions, rehabilitative interventions, behavioral health interventions, and public health and health promotion activities. In early 2010, the Agency for Healthcare Research and Quality (AHRQ) identified the need to establish a national Healthcare Horizon Scanning System to generate information to inform comparative-effectiveness research investments by AHRQ and other interested entities. AHRQ makes those investments in 14 priority areas. For purposes of horizon scanning, AHRQ's interests are broad and encompass drugs, devices, procedures, treatments, screening and diagnostics, therapeutics, surgery, programs, and care delivery innovations that address unmet needs. Thus, we refer to topics identified and tracked in the AHRQ Healthcare Horizon Scanning System generically as "interventions." The AHRQ Healthcare Horizon Scanning System implementation of a systematic horizon scanning protocol (developed between September 1 and November 30, 2010) began on December 1, 2010. The system is intended to identify interventions that purport to address an unmet need and are up to 7 years out on the horizon and then to follow them for up to 2 years after initial entry into the health care system. Since that implementation, more than 11,000 leads about topics have resulted in identification and tracking of more than 900 topics across the 14 AHRQ priority areas and one cross-cutting area.

Methods

As part of the Healthcare Horizon Scanning System activity, a report on interventions deemed as having potential for high impact on some aspect of health care or the health care system (e.g., patient outcomes, utilization, infrastructure, costs) is aggregated twice annually. Topics eligible for inclusion are those interventions expected to be within 0–4 years of potential diffusion (e.g., in phase III trials or for which some preliminary efficacy data in the target population are available) in the United States or that have just begun diffusing and that have completed an expert feedback loop.

The determination of impact is made using a systematic process that involves compiling information on topics and issuing topic drafts to a small group of various experts (selected topic by topic) to gather their opinions and impressions about potential impact. Those impressions are used to determine potential impact. Information is compiled for expert comment on topics at a granular level (i.e., similar drugs in the same class are read separately), and then topics in the same class of a device, drug, or biologic are aggregated for discussion and impact assessment at a class level for this report. The process uses a topic-specific structured form with text boxes for comments and a scoring system (1 minimal to 4 high) for potential impact in seven parameters. Participants are required to respond to all parameters.

The scores and opinions are then synthesized to discern those topics deemed by experts to have potential for high impact in one or more of the parameters. Experts are drawn from an expanding database ECRI Institute maintains of approximately 350 experts nationwide who were invited and agreed to participate. The experts comprise a range of generalists and specialists in the health care sector whose experience reflects clinical practice, clinical research, health care delivery, health business, health technology assessment, or health facility administration perspectives. Each expert uses the structured form to also disclose any potential intellectual or financial conflicts of interest

(COI). Perspectives of an expert with a COI are balanced by perspectives of experts without COIs. No more than two experts with a possible COI are considered out of a total of the seven or eight experts who are sought to provide comment for each topic. Experts are identified in the system by the perspective they bring (e.g., clinical, research, health systems, health business, health administration, health policy).

The topics included in this report had scores *and/or* supporting rationales at or above the overall average for all topics in this priority area that received comments by experts. Of key importance is that topic scores alone are not the sole criterion for inclusion—experts' rationales are the main drivers for the designation of potentially high impact. We then associated topics that emerged as having potentially high impact with a further subcategorization of "lower," "moderate," or "higher" within the potential high impact range. As the Healthcare Horizon Scanning System grows in number of topics on which expert opinions are received, and as the development status of the interventions changes, the list of topics designated as potential high impact is expected to change over time. This report is being generated twice a year.

For additional details on methods, please refer to the full AHRQ Healthcare Horizon Scanning System Protocol and Operations Manual published on AHRQ's Effective Health Care Web site.

Results

The table below lists the 40 topics for which (1) preliminary phase III data for drugs, phase II or III data for devices or procedures, or pilot programs were available; (2) information was compiled and sent for expert comment before April 15, 2012, in this priority area; *and* (3) we received six to eight sets of comments from experts between February 2011 and April 26, 2012. (A total of 285 topics in this priority area were being tracked in the system as of May 2012.) For purposes of the Potential High Impact Interventions Report, we aggregated related topics for summary and discussion (e.g., individual drugs into a class). Topics in this Executive Summary and report are organized alphabetically by disease state and by intervention within that disease state. We present 16 summaries on 19 topics (indicated by an asterisk) that emerged as high impact potential on the basis of expert comments and assessment of potential impact.

Priority Area 02: Cancer

Topics	High Impact Potential
1. *Abiraterone (Zytiga) for treatment of castration-resistant prostate cancer	Moderately high
2. Autologous vascularized lymph node transfer for treatment of mastectomy-associated lymphedema	No high-impact potential at this time
3. Biophotonic system (LightTouch Scanner) for cervical cancer screening	No high-impact potential at this time
4. *B-RAF inhibitor (vemurafenib, Zelboraf) for treatment of metastatic melanoma	High
5. *Brentuximab vedotin (Adcetris) for recurrent or treatment-refractory anaplastic large cell lymphoma	Moderately high
6. *Brentuximab vedotin (Adcetris) for recurrent or treatment-refractory Hodgkin's lymphoma	Moderately high
7. Cologuard fecal DNA test for colorectal cancer screening	No high-impact potential at this time
8. *Concomitant colorectal cancer screening and annual influenza vaccine (FLU-FOBT) program	Lower range of high impact
9. *Crizotinib (Xalkori) ALK inhibitor for treatment of nonsmall cell lung cancer	Moderately high
10. Denosumab (Xgeva) for prevention of cancer-related bone injury	No high-impact potential at this time

Topics	High Impact Potential
11. *Digital, 3-D breast tomosynthesis for breast cancer screening	High
12. Electrical impedance scanner (SciBase III Electrical Impedance Spectrometer) for melanoma diagnosis	No high-impact potential at this time
13. *Hedgehog pathway inhibitor (vismodegib, Erivedge) for treatment of basal cell carcinoma	Moderately high
14. *HER2 dimerization inhibitor (pertuzumab) for treatment of metastatic breast cancer	Moderately high
15. HistoScanning for diagnosis of ovarian masses	No high-impact potential at this time
16. Integrated imaging system (Biograph mMR) for cancer indications	No high-impact potential at this time
17. *Ipilimumab (Yervoy) for treatment of metastatic melanoma	Moderately high
18. *JAK 1/2 inhibitor (ruxolitinib, Jakafi) for treatment of myelofibrosis	Lower range of high impact
19. Levonorgestrel-release intrauterine device for treatment of endometrial precancers and carcinoma	No high-impact potential at this time
20. Liver chemosaturation drug/device combination (melphalan/Chemosat) for treatment of melanoma metastases to the liver	No high-impact potential at this time
21. *MarginProbe System for intraoperatively identifying positive margins during breast cancer lumpectomy	Moderately high
22. MelaFind multispectral dermoscope for detection of melanoma in suspicious skin lesions	No high-impact potential at this time
23. *Methylated Septin 9 blood test for colorectal cancer screening	Lower range of high impact
24. *mTOR inhibitor (everolimus) for treatment of estrogen receptor-positive breast cancer	Moderately high
25. mTOR inhibitor (ridaforolimus) for treatment of soft tissue and bone sarcomas	No high-impact potential at this time
26. *Multikinase inhibitor (cabozantinib) for treatment of metastatic, medullary thyroid cancer	Lower range of high impact
27. Multikinase inhibitor (afatinib) for treatment of nonsmall-cell lung cancer	No high-impact potential at this time
28. Multikinase inhibitor (pazopanib, Votrient) for treatment of soft tissue sarcomas	No high-impact potential at this time
29. *Multikinase inhibitor (vandetanib, Caprelsa) for treatment of metastatic, medullary thyroid cancer	Lower range of high impact
30. Mycobacterial cell wall–DNA complex (Urocidin) for treatment of nonmuscle-invasive bladder cancer	No high-impact potential at this time
31. Off-label metformin for treatment of breast cancer	No high-impact potential at this time
32. Off-label zoledronic acid (Zometa) for primary treatment of multiple myeloma	No high-impact potential at this time
33. PCA3 assay as a triage test to inform biopsy decision making for suspected prostate cancer	No high-impact potential at this time
34. Proteasome inhibitor (carfilzomib, Kyprolis) for treatment of multiple myeloma	No high-impact potential at this time
35. *Radium 223 (Alpharadin) for treatment of bone metastases associated with solid tumors	Moderately high
36. Sedasys computer-assisted sedation system for automated administration of propofol	No high-impact potential at this time

Topics	High Impact Potential
37. Therapeutic cancer vaccine (BiovaxID) for indolent follicular non-Hodgkin's lymphoma	No high-impact potential at this time
38. *Trastuzumab emtansine antibody-drug conjugate for treatment of breast cancer	Moderately high
39. *Tumor-treating fields therapy (NovoTTF-100A System) for brain cancer	Lower range of high impact
40. Vascular endothelial growth factor trap (aflibercept) for treatment of metastatic colorectal cancer	No high-impact potential at this time

Discussion

Overall, topics that emerged as high potential impact included novel drugs and biologics for treatment, novel screening and diagnostic tests, a device used during surgical procedures, and a screening program. Therapeutic areas were solid tumors (advanced basal cell carcinomas, breast cancer, glioblastoma, medullary thyroid cancer, melanoma, nonsmall cell lung cancer, and prostate cancer) and hematologic malignancies (anaplastic large cell lymphoma [ALCL], Hodgkin's lymphoma [HL], and myelofibrosis).

The group of therapeutic agents includes both small-molecule and biologic drugs. The majority of the small-molecule drugs have a well-defined mechanism of action and target a specific signaling pathway. Large-molecule drugs include antibody-drug conjugates (ADCs) directed to tumor-associated surface antigens and an immune stimulator. Diagnostic topics offered potentially simpler or purportedly improved solutions to existing technologies.

Breast Cancer

Digital Breast Tomosynthesis for Mammography Screening

- **Key Facts:** A limitation of two-dimensional (2-D) conventional mammography is that the x-ray images capture information from all tissue constituents along the path from the x-ray source to the detector. Therefore, features of the breast may be obscured by tissues that are in line with the x-ray path and above or below the feature of interest. Digital breast tomosynthesis (DBT) is an x-ray imaging modality that purports to overcome this potential pitfall by imaging stabilized breast tissue in multiple angles for a given view by rotating the x-ray source in an arc around the target tissue. For example, rather than taking a single image in a given view as in conventional 2-D mammography, DBT involves taking 10–20 images with the angle of the x-ray beam shifted by approximately 1 degree in each image. Breast-tissue features that may obscure each other in images taken in one angle will be shifted relative to one another in other angles. By combining the information from each beam angle at the point where it crosses a given depth in the breast under examination, DBT can reconstruct images that represent serial slices through the breast. Developers propose that this imaging technology will improve mammographic imaging, potentially resulting in fewer recalls for inconclusive results, a reduced number of biopsies, and increased cancer detection. The first DBT system, the Selenia® Dimensions® 3D System (Hologic, Inc., Bedford, MA) received marketing approval from the U.S. Food and Drug Administration (FDA) in February 2011, based on results from two clinical trials of the system. This system is a software and hardware upgrade to the existing Selenia Dimensions 2D full-field digital mammography system.

According to data reported to ECRI Institute's PriceGuide service by health care facilities that have purchased a Selenia Dimensions 3-D system, the average price paid was $385,000 in 2011, which represents a $90,000 increase over the cost of the Selenia 2-D system. The high upfront costs of capital equipment acquisition make per-procedure cost for DBT higher relative to conventional 2-D mammography. Additional factors that contribute to increased cost of mammography screening with DBT include extra physician time to analyze multiple image sets, additional equipment-maintenance costs, and an increased need for digital storage and bandwidth to handle breast tomosynthesis data. Although costs per screening are not yet established for DBT, some estimates suggest that breast tomosynthesis exams cost between $200 and $250.

A survey of 11 major, private, third-party payers that publish their policies online identified 7 payers that list coverage determinations for DBT. All seven of these payers consider DBT to be "experimental" and/or "investigational" and do not provide coverage for DBT-based screening or diagnosis.

- **Key Expert Comments:** Experts commenting on this technology thought it has potential to bring incremental improvements in breast cancer screening by potentially improving breast cancer detection and reducing false-positive results. Such reductions, they noted, could obviate the need for unnecessary followup imaging and biopsy, which could save costs and reduce patient anxiety created with false-positive results. Experts thought that, given the likelihood that patients and clinicians would want to use this technology and considering the large changes in health care system costs and resources that its use would cause, DBT has potential for high impact.
- **Potential for High Impact:** High

MarginProbe System for Intraoperatively Identifying Positive Margins During Breast Cancer Lumpectomy

- **Key Facts:** Breast-conserving surgery followed by radiation therapy in patients with early stage breast cancer can achieve recurrence outcomes equivalent to those achieved with total mastectomy; however, to achieve optimal outcomes with this technique, the margins of the tissue excised during surgery must be cancer free. If subsequent pathologic analysis reveals that surgical margins were not clear of cancer, patients may need to undergo a second surgical procedure to remove additional tissue. Therefore, techniques for identifying positive margins during the initial surgical procedure are highly sought. While several techniques have been developed (e.g., frozen sections, touch-prep cytology) the reported rate of secondary surgeries for unclean margins continues to be about 30%. The MarginProbe™ System (Dune Medical Devices, Ltd., Caesarea, Israel) purports to provide an objective means of rapidly assessing surgical margins intraoperatively using a technology called radiofrequency (RF) spectroscopy, which may be able to differentiate between normal tissue and cancerous tissue, based on bioelectric differences between the two tissue types. The MarginProbe algorithm is based on a training set of a large number of comparisons between RF spectroscopy readings and pathology results and provides a binary answer indicating whether the assessed margin is clean. In results from a 664-patient trial of the device, use of the MarginProbe System in combination with standard intraoperative assessment compared with standard intraoperative assessment alone increased the rate at which positive surgical margins were both identified and additional tissue was removed to achieve clean surgical

margins (72% for MarginProbe vs. 22% for standard assessment, p <0.0001), which led to an approximate 50% reduction in the number of patients who underwent a reexcision procedure. Based on this data, a premarket approval (PMA) application was submitted to FDA and has been granted priority review by the agency.

- **Key Expert Comments:** Experts commenting thought this technology has potential to fill a significant unmet need for rapidly assessing surgical margins. Experts suggested that such a technology could significantly improve patient health outcomes by avoiding the need to perform secondary surgeries in a large number of women undergoing breast-conservation surgery. However, experts expressed a desire to see more data that definitively determined whether the system actually improved the rate of positive-margin detection and adequate excision of additional tissue for most patients.
- **Potential for High Impact:** Moderately high

mTOR Inhibitor (Everolimus) for Treatment of Breast Cancer

- **Key Facts:** Inhibitors of the mammalian target of rapamycin (mTOR) have been approved for treating various cancers such as renal cell carcinoma, subependymal giant cell astrocytomas associated with tuberous sclerosis, and pancreatic neuroendocrine tumors. Given their demonstrated efficacy in these cancers and the central role that the mTOR pathway plays in fundamental cellular processes related to tumorigenesis, researchers have undertaken a large number of clinical trials involving the use of mTOR inhibitors in treating a wide variety of cancers. Researchers recently reported results of a study of the mTOR inhibitor everolimus (Afinitor®, Novartis International AG, Basel, Switzerland) for treating estrogen receptor (ER)-positive breast cancer. The everolimus trial studied the drug in combination with the steroidal aromatase inhibitor exemestane in patients whose disease had progressed after treatment with a nonsteroidal aromatase inhibitor (e.g., anastrozole, letrozole). In preliminary results from a 705-patient trial, researchers reported that adding everolimus to exemestane resulted in a statistically significant improvement in progression-free survival of about 4 months. As a drug class, mTOR inhibitors are relatively well tolerated. Commonly reported adverse events included stomatitis/mucositis, rash, and fatigue; however, serious side effects have also been reported such as renal failure, elevated levels of blood glucose and lipids, and immunosuppression (which can lead to increased risk of infections). Regulatory filings for the use of everolimus in ER-positive breast cancer were submitted to FDA in the fourth quarter of 2011, and a decision is anticipated to occur in 2012. Cost information is not available at this time.
- **Key Expert Comments**: Experts commenting on this intervention suggested that results for progression-free survival in endocrine-therapy-resistant metastatic breast cancer were promising for a condition with few treatment options. Experts were eager to see data showing that the observed improvement in progression-free survival translated to improved overall survival, before indicating that mTOR inhibitors would have a large impact on patient outcomes.
- **Potential for High Impact:** Moderately high

Novel HER2-Targeted Therapies for Treatment of Breast Cancer

- **Key Facts:** HER2-positive breast cancer is a subclass of invasive breast cancer characterized by expression of high levels of epidermal growth factor receptor (EGFR) family member HER2. This subtype comprises approximately 20% of breast cancer cases. This cancer subtype has been associated with more aggressive disease and poorer outcomes. While treatment of HER2-positive breast cancer improved with the availability of HER2-targeted therapies such as trastuzumab (Herceptin®) and lapatinib (Tykerb®), many patients' cancers still progress with these treatments, and compounds with improved efficacy and/or efficacy against resistant disease are highly desired.

  Two novel biologic therapies are in late-stage clinical trials for treating HER2-positive breast cancer: trastuzumab emtansine and pertuzumab (Omnitarg®, F. Hoffmann-La Roche, Ltd., Basel, Switzerland). Trastuzumab emtansine (also being developed by Roche), formerly known as trastuzumab-DM1, is an ADC that couples an HER2-specific monoclonal antibody (trastuzumab) to a potent chemotherapeutic agent, the microtubule assembly inhibitor emtansine (DM1). They are coupled in such a way that emtansine is held in a stable inactive form outside of the cell; only upon cellular uptake of the drug conjugate mediated by binding of the antibody to the HER2 receptor is emtansine released and activated. In this way, the cytotoxic activity of emtansine is targeted to cells expressing the HER2 receptor, potentially sparing many normal tissues from the toxic effects of the drug. Trastuzumab emtansine is in many phase III trials for metastatic breast cancer. Roche recently announced that one of these trials (EMILA) testing trastuzumab emtansine against the standard second-line treatment of lapatinib and capecitabine had met its primary endpoint of improving progression-free survival. A regulatory submission for this indication is expected to be completed in 2012.

  Pertuzumab is a novel HER2-specific monoclonal antibody that binds to a different site on the HER2 receptor than the available monoclonal antibody trastuzumab (Herceptin®). Mechanistically, pertuzumab is purported to prevent the interaction of HER2 with other HER family receptors, which is required for their activation and role in breast cancer pathogenesis. Because pertuzumab functions through a distinct mechanism of action from trastuzumab, use of these two HER2-specific antibodies in combination may improve outcomes. Like trastuzumab-emtansine, pertuzumab is in multiple phase III trials for treating both patients with localized breast cancer in the adjuvant (postsurgery) setting and patients with metastatic breast cancer. The most advanced trial of pertuzumab studied the addition of pertuzumab to a standard first-line treatment for metastatic breast cancer (trastuzumab plus docetaxel). Preliminary results indicated that the addition of pertuzumab extended progression-free survival by about 6 months in this patient population. A regulatory submission for this indication has been submitted to FDA and was granted priority review status by the agency.

- **Key Expert Comments**: Overall, experts commenting on these interventions believe that trastuzumab emtansine and pertuzumab have significant potential to provide an incremental improvement upon existing HER2-positive metastatic breast cancer treatments, the shortcomings of which they thought represented a significant unmet need. Experts also thought that trastuzumab emtansine's potential to displace current standard of care treatments for HER2-positive metastatic breast cancer and likely high cost of both

trastuzumab emtansine and pertuzumab could have significant impacts on the management of these patients.

- **Potential for High Impact:** Moderately high

Colorectal Cancer

Concomitant Colorectal Cancer Screening and Annual Influenza Vaccine (FLU-FOBT) Program

- **Key Facts:** While adherence to colorectal cancer (CRC) screening guidelines has been demonstrated to reduce CRC-related mortality, only a minority of the population adheres to CRC screening guidelines, and about 50% of CRCs diagnosed in the United States are diagnosed at late disease stages. Therefore, innovations that have the potential to improve CRC screening rates are highly sought. The FLU-FOBT (fecal occult blood test) program is an initiative that seeks to target the provision of CRC information and noninvasive FOBT kits to patients accessing the health care system to receive annual influenza vaccines. Influenza vaccination and CRC screening are in some ways natural partners because both are targeted to elderly patients and it is recommended that both influenza vaccination and fecal occult blood testing be performed annually. Pilot programs run in various care settings (e.g., hospital-based/managed-care based influenza vaccine clinics, pharmacy-based influenza vaccination campaigns, community health care clinics, primary care centers) by researchers at the University of California, San Francisco, demonstrated improved rates of FOBT completion and overall rates of CRC screening among patients who were part of FLU-FOBT-like programs compared with patients who only received an influenza vaccination.
- **Key Expert Comments:** Experts commenting on this intervention believe it is an interesting approach to increasing CRC screening rates that has significant potential to improve screening adherence in certain settings. However, experts questioned whether such a program could be implemented on a large scale, thereby limiting their view of its overall potential impact.
- **Potential for High Impact:** Lower range of high impact

Methylated Septin 9 Blood Test for Detection of Colorectal Cancer

- **Key Facts:** Research has demonstrated that cells undergo a range of epigenetic modifications (e.g., DNA methylation) during transformation to cancerous cells. In particular, elevated levels of certain methylated DNA species have been observed in the blood of patients with CRC, which could serve as a readily accessible marker for cancer screening. One such marker that has been shown to be present specifically in the blood of individuals with CRC is a methylated DNA derived from the S*eptin 9* gene, detection of which is being studied as a potential colon cancer screening test. Like other noninvasive colon cancer tests (e.g., FOBT), a positive result from the methylated Septin 9 test would require that the patient undergo a colonoscopy to confirm the result and biopsy and/or resect any suspect lesions. The methylated Septin 9 test is being developed by Epigenomics AG, Berlin, Germany, in collaboration with Abbott Laboratories, Abbott Park, IL. In 2011, Epigenomics reported data from a trial in which a subset of 7,940 patients undergoing colonoscopy screening were also tested with the current version of the company's Septin 9

test (Epi procolon 2.0). The company reported that, compared with colonoscopy, the Septin 9 test had a sensitivity of 68% and a specificity of 80% for colorectal cancer. Data on the test's ability to detect precancerous, adenomatous polyps were not presented. Epigenomics has begun to submit data to FDA in support of a PMA application.

- **Key Expert Comments:** Overall, most experts commenting on this intervention thought that an accurate blood-based CRC screening test obtained through venipuncture (rather than testing a stool sample) could fundamentally change CRC screening practices by increasing the percentage of patients screened for CRC. However, regarding the Epi proColon 2.0 test specifically, experts were more cautious, questioning whether the reported sensitivity and specificity of the test were high enough and whether the high cost they anticipated for the test relative to other noninvasive options such as fecal occult blood testing would prevent its widespread adoption.
- **Potential for High Impact:** Lower range of high impact

Glioblastoma

Tumor-Treating Fields Therapy (NovoTTF-100A System) for Brain Cancer

- **Key Facts:** Tumor-treating fields therapy (NovoTTF-100A™, NovoCure, Ltd., St. Helier, Jersey Isle) is a novel treatment modality in which a patient's tumor is exposed to alternating electric fields of low intensity and intermediate frequency, which are purported to both selectively inhibit tumor growth and reduce tumor angiogenesis. Tumor-treating fields are delivered by a battery-powered portable device that generates the fields via disposable electrodes that are noninvasively attached to the patient's skin around the site of the tumor. The device is used by the patient at home on a continuous basis. The delivery device was approved for treatment-refractory glioblastoma in April 2011 and represents both a novel cancer treatment modality and a salvage therapy option that appears to have few adverse effects. The approval was based on results of a 237-patient randomized, controlled trial comparing tumor-treating fields to the clinician's chemotherapy of choice. Researchers reported that patients in the tumor-treating fields arm of the trial exhibited similar overall survival times to patients in the chemotherapy arm; median 6.6 months (n=120) versus median 6.1 months (n=117), respectively. Additionally, researchers reported that patients in the tumor-treating fields arm reported fewer side effects and improved quality of life compared with patients in the chemotherapy arm. The therapy is undergoing study as a treatment for newly diagnosed glioblastoma multiforme in combination with maintenance temozolomide. An alternate version of the device is under study as second-line treatment in combination with pemetrexed for advanced nonsmall cell lung cancer (NSCLC).
- **Key Expert Comments:** Although experts were generally enthusiastic about the idea of a therapy with a novel mechanism of action and a seemingly low side-effect profile, experts cautioned that the data suggest the therapy exhibits marginal, if any, survival benefit over alternative salvage therapies. Additionally, experts suggested that both patients and clinicians may be unlikely to adopt an unorthodox therapy administered at home without more data demonstrating its efficacy, unless it represents the only available treatment option.
- **Potential for High Impact**: Lower range of high impact

Hematologic Malignancies

Antibody-Drug Conjugate: Brentuximab Vedotin (Adcetris) for Treatment of Hodgkin's Lymphoma and Anaplastic, Large Cell Lymphoma

- **Key Facts:** ADCs represent a class of cancer treatments in which highly toxic chemotherapy agents are coupled to monoclonal antibodies specific for molecules present on the surface of cancer cells. These targeted therapeutic agents are intended to deliver high doses of cytotoxic therapy to tumor cells while simultaneously reducing systemic side effects associated with untargeted chemotherapy. CD30-positive malignancies such as HL and ALCL are rare, with only about 8,500 cases of HL and 2,250 cases of ALCL diagnosed annually in the United States. Although initial treatments for these conditions, in particular HL, are effective, patients with HL and ALCL often experience relapse, and in many cases the disease becomes resistant to available therapies. This has resulted in increased demand for new therapeutic options for recurrent/refractory disease. Brentuximab vedotin (Adcetris®, Seattle Genetics, Inc., Bothell, WA, in collaboration with the Millennium Pharmaceuticals subsidiary of Takeda Pharmaceutical Co., Ltd., Osaka, Japan) is an ADC that consists of a monoclonal antibody covalently attached to a potent, chemotherapeutic agent. It is intended to target CD30-expressing tumor cells and contains a novel linking system designed to allow it to remain stable in the bloodstream and only release its cytotoxic drug upon penetration of CD30-positive cells. Common adverse effects reported in trials included nausea, fatigue, peripheral neuropathy, pyrexia, diarrhea, and neutropenia, which were characterized as "manageable." Rare, but serious adverse events reported were progressive multifocal leukoencephalopathy, a brain infection that can result in death. In August 2011, FDA approved brentuximab vedotin for HL that has failed to respond to an autologous stem cell transplantation or that has progressed after at least two multi-agent chemotherapy regimens in patients who are not autologous stem cell transplant candidates. FDA approved the drug for treating ALCL after failure of at least one multi-agent chemotherapy. The initial drug pricing was set at about $4,500 per vial with about three vials used per treatment and 7–9 cycles of treatment given per patient, bringing the total cost for a complete regimen to a range of $94,000–$121,000.
- **Key Expert Comments:** Overall, experts concurred that a significant unmet need exists for efficacious treatments for relapsed/refractory HL and ALCL. Given the lack of effective alternatives and the promising response rates demonstrated in initial clinical trials, experts believe that wide adoption by physicians and patients is likely. However, the routine method of brentuximab vedotin administration and the relatively small patient population that would be eligible for brentuximab vedotin treatment would limit its overall impact.
- **Potential for High Impact:** Moderately high

JAK 1/2 Inhibitor (Ruxolitinib, Jakafi) for Treatment of Myelofibrosis

- **Key Facts:** Myelofibrosis is a relatively rare myeloproliferative neoplasm characterized by bone marrow fibrosis, progressive anemia, and hematopoiesis that occurs outside of the bone marrow that typically results in an enlarged spleen. Until approval of ruxolitinib in November 2011, no pharmacotherapy had been FDA-approved for treating myelofibrosis. Ruxolitinib is a small-molecule inhibitor of two tyrosine kinases (JAK1 and JAK2) that

function in the JAK/STAT pathway. Active JAK/STAT signaling promotes two important aspects of myelofibrosis disease pathogenesis: (1) clonal myeloproliferation (many cases of myelofibrosis harbor genetic mutations that lead to JAK/STAT pathway activation, in particular an activating mutation in JAK2) and (2) a proinflammatory state mediated by overexpression of cytokines. In two phase III clinical trials, treatment with ruxolitinib was reported to have led to significant improvements in spleen size and constitutional symptoms (e.g., fatigue); however, ruxolitinib treatment has not yet been shown to generate clear improvements in overall survival. Additionally, treating patients with ruxolitinib may actually exacerbate the anemia symptoms of myelofibrosis. Ruxolitinib was developed by Incyte Corp. (Wilmington, DE), which has reportedly priced the drug at $7,000 per month. Most third-party payers list the drug as a specialty pharmaceutical requiring prior authorization for reimbursement.

- **Key Expert Comments:** Overall, experts believe that ruxolitinib addresses a significant unmet need for novel treatments for myelofibrosis and that the mechanism of action of ruxolitinib is highly suited to this indication. While experts believe that it would likely be adopted by physicians and patients based on encouraging data regarding spleen size, experts were cautious, given the lack of data on patient survival and disease progression. Lastly, experts did not envision an oral medication intended for use in a relatively small patient population as having significant impacts on the health care system.
- **Potential for High Impact:** Lower range of high impact

Lung Cancer

ALK Inhibitor Crizotinib (Xalkori) for Treatment of Nonsmall Cell Lung Cancer

- **Key Facts:** Current chemotherapy options for patients with advanced NSCLC yield a relatively low response rate (25% to 30%) and 2-year survival rates of only 10% to 15%. Therefore, the need for new treatments is significant. In recent years it has become clear that like other cancers, NSCLC is not a single disease, but rather a collection of related diseases with different molecular underpinnings. In particular, 2% to 7% of NSCLC tumors harbor genetic alterations that result in a fusion of the *ALK* gene with a second gene (often *EML4).* These gene fusions can result in production of a constitutively active ALK protein that can drive carcinogenesis. Targeted inhibition of activated ALK is seen by experts as a promising therapeutic target for these individuals. Crizotinib (Xalkori®, Pfizer, Inc., New York, NY) is a small-molecule inhibitor of ALK kinase activity taken orally once daily. In August 2011, FDA granted the drug accelerated approval on the basis of two single-arm, phase II clinical trials that exhibited a high rate of response to crizotinib therapy. Crizotinib is indicated for patients with locally advanced or metastatic NSCLC that is *ALK*-positive as detected by an FDA-approved companion diagnostic test, the Vysis ALK Break Apart FISH Probe Kit. The drug cost is about $115,000 per patient per year ($9,600 per month) and the list price of the companion diagnostic test is about $225 per test; however, the full cost of the test will also include a fee for the performance of the test. Two phase III, randomized controlled trials of crizotinib in the first- and second-line treatment setting are ongoing. The drug is listed as a specialty pharmaceutical with 11 major third-party payers that publish their coverage

policies, and the drug requires prior authorization for reimbursement. The company has a payment assistance program for select patients.

- **Key Expert Comments:** Experts commenting on this topic thought that the availability of an ALK inhibitor and its companion diagnostic test to identify patients who would be more likely to benefit from this treatment represent a significant advance in treatment options for this patient population. Additionally, experts suggested that the drug's availability would likely necessitate genetic profiling for most or all patients with NSCLC, potentially altering patient management and increasing costs associated with diagnosis and treatment decisions. However, experts noted that the small percentage of patients with NSCLC who are *ALK* mutation-positive would limit overall health impact for all patients with NSCLC.
- **Potential for High Impact:** Moderately high

Prostate Cancer

Abiraterone (Zytiga) for Treatment of Metastatic Castration-Resistant Prostate Cancer

- **Key Facts**: Until 2010, patients with a form of prostate cancer that had become resistant to first-line hormone therapy (castration-resistant prostate cancer [CRPC]) had only the chemotherapeutic agent docetaxel as an option that improved survival in some patients. The armamentarium for treatment grew in 2010 with FDA approval of the chemotherapeutic agent cabazitaxel (Jevtana®) and the therapeutic cancer vaccine sipuleucel-T (Provenge®). The latest addition to treatment options for metastatic, castration-resistant prostate cancer (mCRPC) came in April 2011 with approval of abiraterone (Zytiga®, Johnson & Johnson, New Brunswick, NY). Abiraterone is intended to improve on current methods of reducing androgen signaling, which is known to promote prostate cancer growth. Abiraterone has expanded the use of androgen inhibitors to a later stage of prostate cancer previously thought to be independent of androgen signaling. Experts commenting on abiraterone thought significant changes in the management of mCRPC would be seen as physicians incorporate new therapies such as abiraterone, cabazitaxel, and sipuleucel-T into practice guidelines. Abiraterone's cost has been reported as about $5,000 per month of treatment. A query of an online pharmacy in January 2012 identified a retail price of $6,840 for a 30-day abiraterone supply. Searches of 11 major, private, third-party payers that publish their policies online indicated that third-party payers generally reimburse the use of abiraterone for the FDA-approved indication and list the drug as a specialty pharmaceutical requiring prior authorization for reimbursement.
- **Key Expert Comments**: Overall, experts thought abiraterone has high potential to improve both quality and quantity of life for patients with mCRPC; however, some experts pointed out that the demonstrated improvement in survival duration is only a few months in patients whose disease has not responded to first-line chemotherapy. They also noted that results from a study of abiraterone for chemotherapy-naïve CRPC are highly anticipated.
- **Potential for High Impact**: Moderately high

Radium 223 (Alpharadin) for Treatment of Bone Metastasis

- **Key Facts:** Many solid tumors, in particular breast, prostate, and lung cancer, metastasize to bone, causing chronic pain and skeletal-related events (e.g., fractures) that adversely affect both patient quality of life and survival. Among the treatment options for bone metastases are radioactive molecules that have a natural affinity for sites of bone remodeling, which occurs at bone metastases. Preferential accumulation of the radioactive compound purportedly functions to concentrate the radiation dose at the target bone metastases. Although available radionuclides have shown efficacy in palliating bone pain, the type of radiation that they emit penetrates tissues deeply enough to negatively affect the bone marrow, which limits the deliverable dose and restricts their use to one of symptom palliation. Alpharadin® (a preparation of radium 223 developed by Algeta ASA, Oslo, Norway, and Bayer AG, Leverkusen, Germany) is a novel bone metastasis-targeting radiopharmaceutical that emits alpha particles, which have higher energies and more localized activity than radiation generated by available radiopharmaceuticals, potentially reducing the side-effect profile of treatment and more effectively targeting bone metastases. Recent results reported by the developers from a randomized, double-blind trial of 900 patients with CRPC with skeletal metastases who were ineligible for initial treatment or further treatment with docetaxel indicated an increase overall survival of almost 3 months in patients treated with Alpharadin compared with patients treated with placebo. An independent committee recommended that the trial be stopped early because of the positive results. Besides improving overall survival, treatment with Alpharadin was also reported to have improved secondary endpoints such as the time to first skeletal-related event, percentage of patients achieving normalized total alkaline phosphatase levels, and time to biochemical disease progression. Side effects were reported as being relatively benign, suggesting that it could potentially be used in combination with other prostate cancer treatments. Alpharadin was granted fast track status by FDA for treating CRPC with bone metastases. The developers expected to submit an NDA for this indication in 2012. Alpharadin is also in phase II study for treating breast cancer bone metastases.
- **Key Expert Comments:** Experts commenting on this topic thought that Alpharadin has significant potential to improve on current treatments for bone metastases, particularly for patients with prostate cancer. While experts thought Alpharadin would likely be widely adopted for this indication, the highly similar nature of Alpharadin to existing treatments suggested to experts that its adoption would have limited impact on health care system infrastructure and practices.
- **Potential for High Impact:** Moderately high

Skin Cancer

B-RAF Inhibitor Vemurafenib (Zelboraf) for Treatment of Metastatic Melanoma

- **Key Facts**: B-RAF inhibitors belong to a growing class of personalized cancer treatments. Use of these treatments is intended for patients whose tumors harbor specific genetic changes that are targeted by the therapies and, therefore, are likely to respond. Identifying the appropriate patients for these therapies requires testing all patients with the cancer to

identify the subset of patients for whom such personalized therapy may be appropriate. B-RAF plays a central role in the RAS/MAP kinase signal transduction pathway, which regulates cell growth and cell proliferation. Misregulation of this pathway has been demonstrated to be involved in multiple cancers. In particular, mutant versions of the *B-RAF* gene that encode a constitutively active B-RAF protein (e.g., B-RAF^{V600E}) have been identified in more than half of melanomas analyzed. Activated B-RAF is proposed to lead to hyperactivation of the downstream ERK/MEK/MAP kinase pathway, upon which melanomas may be dependent for growth and survival. Therefore, the specific inhibition of B-RAF kinase activity is a promising pharmacologic target. Two orally administered, small-molecule inhibitors of B-RAF kinase activity were considered by experts to have high potential impact: vemurafenib (Zelboraf®, Genentech unit of Roche) and dabrafenib (GlaxoSmithKline, Middlesex, UK). Researchers reported that vemurafenib increased overall survival and progression-free survival relative to treatment with dacarbazine. In August 2011, FDA approved vemurafenib for treating patients with unresectable or metastatic melanoma harboring a *B-RAF* mutation as detected by an FDA-approved companion diagnostic test, the cobas 4800 *B-RAF V600* Mutation Test. The cost is about $9,400 per patient per month and the company estimates a treatment course of about 6 months for a total of about $56,400 per patient. Most third-party payers list the drug as a specialty pharmaceutical requiring prior authorization for reimbursement. Genentech introduced the Zelboraf Access Solutions program to help some patients cover out-of-pocket costs using a special company-issued copayment card. A second B-RAF inhibitor, dabrafenib, is being studied in a 200-patient, phase III trial with results anticipated by June 2012.

- **Key Expert Comments:** Experts commenting on this topic thought that the availability of B-RAF inhibitors has potential to fundamentally change treatment paradigms for metastatic melanoma because they will split a single syndrome into *B-RAF* mutation-positive and *B-RAF* mutation-negative disease. This will necessitate testing of all patients to determine their *B-RAF* status. Experts opined that while the potential of B-RAF inhibitors is limited by the fact that the vast majority of patients will eventually develop resistance to the therapy, these inhibitors are expected to be a central focus of melanoma treatment and clinical study in coming years.
- **Potential for High Impact:** High

Hedgehog Pathway Inhibitor Vismodegib (Erivedge) for Treatment of Basal Cell Carcinoma

- **Key Facts:** Until the recent FDA approval of vismodegib (Erivedge®), no systemic therapy was approved for basal cell carcinomas that are not suitable for surgery. Vismodegib is an orally available, small-molecule inhibitor of a signaling pathway known as the Hedgehog pathway, the aberrant regulation of which has been implicated in a number of cancers. In particular, elevated levels of Hedgehog pathway activity have been observed in the majority of basal cell carcinomas and preclinical data suggested that inhibition of this pathway could have an antitumor effect. In results from a single-arm, phase II trial of vismodegib in treating 104 patients with locally advanced or metastatic basal cell carcinoma, investigators reported that vismodegib resulted in a 43% response rate for locally advanced disease, a 30% response rate for metastatic disease, and 9.5 months of progression-free survival. The most common adverse events reported in the trial included muscle spasms, hair loss, altered

taste sensation, weight loss, fatigue, nausea, decreased appetite, and diarrhea. Additionally, serious adverse events were observed in 26 patients of which 4 (blocked bile flow from the liver, dehydration with loss of consciousness, pneumonia accompanied by cardiac failure, and pulmonary embolism) were considered vismodegib-related. FDA approved the drug in January 2012. Genentech announced that vismodegib's average wholesale cost will be $7,500 per month per patient, and the estimated duration of treatment is 10 months. Third-party payers will list the drug as a specialty pharmaceutical requiring prior authorization for reimbursement. Genentech established a program called Access Solutions to facilitate access, including for patients who cannot afford the drug because of large copayments or lack of prescription drug insurance.

- **Key Expert Comments:** Experts commenting on this topic thought that vismodegib has significant potential as a first-in-class agent for treating basal cell carcinoma. Experts cited the compelling response rates in reported data thus far and a patient population lacking a systemic treatment option as the main factors signaling the potential importance of this drug; however, they wanted to see longer-term data and survival data. Experts thought that vismodegib's potential impact on the health system as a whole would be mitigated by the relatively small number of patients who would be targeted by this therapy.
- **Potential for High Impact:** Moderately high

Ipilimumab (Yervoy) for Treatment of Metastatic Melanoma

- **Key Facts:** According to the American Academy of Dermatology, more than half of all new cases of melanoma are invasive at the time of diagnosis. Until recently, no clearly optimal treatments for metastatic melanoma were available. The monoclonal antibody ipilimumab (Yervoy™, Bristol-Myers Squibb, New York, NY) is an immunotherapy that attempts to modulate an existing immune response to leverage that response. Ipilimumab has the potential to confront the problem of immune tolerance (i.e., lack of an immune response) to many cancers, in particular melanoma. The recent approval of ipilimumab and the B-RAF inhibitor vemurafenib (Zelboraf) represent the first therapies to demonstrate an improvement in overall survival. Based on results of a trial in which ipilimumab increased overall survival by about 4 months, FDA granted marketing approval in March 2011 for ipilimumab as a therapy for advanced melanoma. The drug's estimated per patient cost is $120,000 for a course of four infusions. More recently, data were published on ipilimumab as first-line therapy for metastatic melanoma in combination with the chemotherapeutic agent dacarbazine. Researchers reported a statistically significant improvement in overall survival of about 2 months for the ipilimumab group over the placebo group. Ipilimumab has a black box warning regarding the development of fatal immune-mediated adverse reactions due to T-cell activation and proliferation, which may involve any organ system; the most common reactions include dermatitis, endocrinopathy, enterocolitis, hepatitis, and neuropathy.
- **Key Expert Comments:** Experts commenting on this intervention thought that clinical trials of ipilimumab demonstrated that the drug has a significant potential to meet an important unmet need for therapies that could improve overall survival in metastatic melanoma. However, this enthusiasm was tempered by the relatively small number of patients who achieved long-term benefit from the drug and the potential for serious adverse events. Despite these caveats, experts believe that ipilimumab would be widely adopted and that the

high cost of the therapy would have a significant impact on the cost of care for this patient population.

- **Potential for High Impact**: Moderately high

Thyroid Cancer

Multikinase Inhibitors Vandetanib (Caprelsa) and Cabozantinib for Treatment of Medullary Thyroid Cancer

- **Key Facts:** Medullary thyroid cancer is a rare form of thyroid cancer (about 1,500 cases per year) for which no effective treatment option was available for advanced disease that is not amenable to surgical resection before 2011. In April 2011, FDA approved vandetanib (Caprelsa®, AstraZeneca, London, UK) as the first, and thus far only medication specifically indicated for treating medullary thyroid cancer. Vandetanib is a small-molecule kinase inhibitor with activity against multiple tyrosine kinases that control multiple cancer-related cellular processes. Among vandetanib's targets is the RET (rearranged during transfection) receptor tyrosine kinase, mutations in which have been linked with both sporadic and familial forms of medullary thyroid cancer. Researchers reported results from a 231-patient randomized controlled trial stating that progression-free survival was longer for patients receiving the drug than for patients in the placebo arm; however, no difference was observed between groups for overall survival. The prescribing information for vandetanib carries a black box warning regarding the risks of heart rhythm abnormalities (QT prolongation, torsades de pointes) and sudden death. Only prescribers and pharmacies certified through the manufacturer's Risk Evaluation and Mitigation Strategy program, a restricted distribution program, may prescribe and dispense vandetanib. Reported cost for a 30-day supply of 300 mg vandetanib, taken once daily, is about $10,000. Third-party payers list the drug as a specialty pharmaceutical requiring prior authorization.

  Studies of additional tyrosine kinase inhibitors with anti-RET activity are also under way for treating medullary thyroid cancer, and results from a late-stage clinical trial of cabozantinib (Exelixis, Inc., South San Francisco, CA) were recently reported. The developer announced that cabozantinib had met its primary endpoint of improving progression-free survival compared with placebo. An NDA was expected to be completed in the first half of 2012.
- **Key Expert Comments:** Experts commenting on these inhibitors thought that the availability of vandetanib and the potential availability of cabozantinib for treating metastatic medullary thyroid cancer represented a significant improvement in available treatment options for this condition. However, experts believe that the small patient population eligible for this treatment and the routine nature of its administration would limit the drugs' overall impact.
- **Potential for High Impact:** Lower range of high impact

Breast Cancer Interventions

Digital Breast Tomosynthesis for Breast Cancer Screening

Conventional mammography uses x-rays to capture two-dimensional images of breast tissue.[1] A limitation of conventional mammography is that the x-ray images capture information from all tissue constituents along the path from the x-ray source to the detector.[2] Therefore, features of the breast may be obscured by tissues that are in line with the x-ray path and above or below the feature of interest.

Digital breast tomosynthesis (DBT) is a new x-ray imaging modality that purports to overcome this potential pitfall by imaging stabilized breast tissue in multiple angles for a given view by rotating the x-ray source in an arc around the target tissue. For example, rather than taking a single image in the craniocaudal view as in conventional two-dimensional (2-D) mammography, DBT involves taking 10–20 images in the craniocaudal view with the angle of the x-ray beam shifted by approximately 1 degree in each image.[2] Breast tissue features that may obscure each other in one angle will be shifted relative to one another in other angles. By combining the information from each beam angle at the point where it crosses a given depth in the breast under examination, DBT can reconstruct images that represent serial slices through the breast. Developers propose that this imaging technology will improve mammographic imaging, potentially resulting in the following:[2]

- Fewer recalls of women for followup because of inconclusive mammography results
- A reduction in the number of biopsies
- Increased cancer detection

The first DBT system to be approved by FDA, the Selenia® Dimensions® 3D System manufactured by Hologic, Inc. (Bedford, MA), received marketing approval from the U.S. Food and Drug Administration in February 2011 based on results from two clinical trials of the system. This system is a software and hardware upgrade to the existing Selenia Dimensions 2D full-field digital mammography system.[3,4]

In the first trial, 312 cases (of which 48 were biopsy-confirmed breast cancer) were imaged using conventional 2-D mammography and three dimensional (3-D) digital tomosynthesis.[5] Twelve radiologists who had received training in the interpretation of 3-D digital tomosynthesis images then interpreted the cases based on the 2-D data alone and based on a combination of the 2-D data and the 3-D tomosynthesis data. The study measured the area under the receiver operating characteristic (ROC) curve and the recall rate of noncancer cases. Researchers reported that interpretation of 2-D plus 3-D tomosynthesis data showed an improved area under the curve relative to interpretation of 2-D data alone for all experts (average increase in area of 0.071 for the American College of Radiology's breast imaging reporting and data system [BI-RADS®] ROC analysis [p=0.0004] and 0.072 for the probability of malignancy ROC analysis [p=0.0001]).[5] They also reported that interpretation of 2-D plus 3-D tomosynthesis data exhibited a reduction in the recall rate for noncancer cases relative to interpretation of 2-D data alone with a reduction in the average recall rate from 51.5% to 12.9%.[5]

In the second study, 310 cases (of which 51 were biopsy-confirmed breast cancer) were imaged using conventional 2-D mammography and 3-D digital tomosynthesis.[5] Fifteen radiologists who had received training in the interpretation of 3-D digital tomosynthesis images then interpreted the cases based on the following: (1) 2-D data alone; (2) a combination of 2-D data and 3-D tomosynthesis data from only the mediolateral oblique (MLO) view; and (3) a combination of 2-D data and 3-D tomosynthesis data from both the MLO view and the craniocaudal view. The study measured the area under the ROC curve and the recall rate of noncancer cases. Researchers reported that interpretation of 2-D plus 3-D tomosynthesis data in both views exhibited significant

improvement in the area under the ROC curve compared with both 2-D data alone and 2-D data in combination with 3-D tomosynthesis MLO data.[5] They reported that recall rates for noncancer cases were 48.8% for 2-D data alone, 32.7% for 2-D plus 3-D MLO data, and 30.1% for 2-D plus full 3-D tomosynthesis data.[5]

Besides Hologic, several other developers are working to bring DBT systems to market in the United Sates (e.g., General Electric Co., Siemens AG).[6] However, these DBT systems appear to be a year or more from commercial availability in the United States.

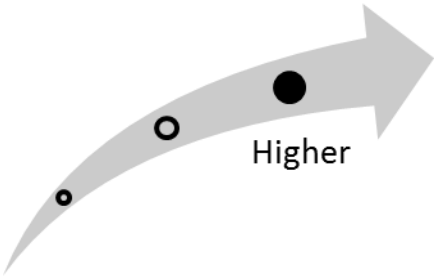
Hologic has indicated that the list price of the digital tomosynthesis option for the Selenia Dimensions system is $150,000.[7] According to data reported to ECRI Institute's PriceGuide service by health care facilities that have purchased a Selenia Dimensions 3-D system, the average price paid was $385,000, which represents a $90,000 increase over the cost of the Selenia 2-D system.

Due in part to the high upfront costs of capital equipment, the cost per procedure for DBT is higher relative to conventional 2-D mammography. Additional factors that contribute to an increased cost of mammography screening with breast tomosynthesis include extra physician time to analyze multiple image sets, additional equipment maintenance costs, and an increased need for digital storage and bandwidth to handle breast tomosynthesis data. Although costs per screening are not yet established for DBT, some estimates suggest that breast tomosynthesis exams cost between $200 and $250.[5,8] A survey of 11 major, private, third-party payers that publish their policies online (i.e., Aetna, Anthem, Blue Cross/Blue Shield Alabama, Blue Cross/Blue Shield Massachusetts, CIGNA, HealthPartners, Humana, Medica, Regence, Wellmark, United Healthcare) identified 7 payers that list coverage determinations for DBT.[9-15] All seven of these payers consider DBT to be "experimental" and/or "investigational" and so do not provide coverage for DBT-based screening or diagnosis.

Clinical Pathway at Point of This Intervention

Primary breast cancer screening is typically performed using 2-D digital or film x-ray mammography.[16] After identification of an abnormality on screening mammography, patients typically undergo additional diagnostic imaging (e.g., diagnostic mammography, ultrasound, magnetic resonance imaging) and a physical examination. If these studies suggest the abnormality is cancerous, biopsy material may be obtained by fine-needle aspiration, core-needle biopsy, or open surgical biopsy.[16] The Selenia Dimensions 3D tomosynthesis system would be used in place of conventional 2-D x-ray mammography for breast cancer screening and followup diagnostic imaging of suspicious lesions.[5]

Figure 1. Overall High Impact Potential: Digital breast tomosynthesis for breast cancer screening



Overall, experts providing comments on this technology thought that it has potential to bring incremental improvements in breast cancer screening by potentially improving breast cancer detection and reducing false-positive results. Such reductions, they opined, could obviate need for

unnecessary followup imaging and biopsy, which could save costs and reduce patient anxiety created with false-positive results. Experts thought that, given the likelihood that patients and clinicians would want to use this technology and the large changes in health care system costs and resources that its use would cause, DBT has potential high impact. Based on this input, our overall assessment is that this intervention is in the higher end of the high-potential-impact range.

Results and Discussion of Comments

Eight experts, with clinical, research, health systems, and health administration backgrounds, provided perspectives on this topic.[17-24] The consensus among experts was that digital tomosynthesis has the potential to address two significant unmet needs in breast cancer screening: (1) finding cancers that conventional screening mammography misses, particularly in women with dense breasts, for whom conventional mammography has poor sensitivity; and (2) reducing the high rate of inconclusive or false-positive results seen with conventional mammography, which leads to many unnecessary recalls for followup imaging and biopsies.

While experts agreed that DBT has the potential to improve sensitivity and specificity relative to conventional mammography, they were less certain about how large an impact digital tomosynthesis would have on these unmet needs. Multiple experts noted the incremental nature of the improvement in sensitivity and specificity. In addition, one clinical expert questioned whether data from a retrospective study of a case series enriched with cancer cases should be generalized to the screening population, where breast cancer rates would be much lower. This expert suggested that digital tomosynthesis might initially be best used by being reserved for high-risk patients and/or patients with dense breast tissue. Ultimately, multiple experts suggested that ongoing large clinical trials comparing DBT with 2-D digital images would need to be completed before a clear case for switching to DBT in the screening setting could justified. Lastly, one expert with a clinical background noted that besides its purported benefits, DBT could add to the problem of breast cancer over-diagnosis, in which slow-growing noninvasive carcinomas that might not have affected patient health are detected and treated. An expert with both a research and health systems perspective believes it has a high likelihood of becoming a replacement screening tool over time as hospitals upgrade their screening mammography technology, based on the assumption that it can potentially improve cancer detection, lower recall rates, and lower the proportion of biopsies that turn out to be negative because of a false-positive result from the prior screening.

Even if digital tomosynthesis provides only marginal improvements in sensitivity and specificity, experts thought, patients would be eager to receive screening with this technology, because it is the most advanced breast screening technology available. However, some experts noted that patients may fear the increase in radiation dose incurred during DBT compared with conventional mammography.

Multiple experts noted that adoption of DBT as a screening tool would have significant impacts on health care facility infrastructure and staffing. They pointed out that facilities wishing to offer it would not only need to acquire the imaging system itself, but also increase digital bandwidth, data storage capacity, and the number of viewing workstations to accommodate the increased data generated by a tomosynthesis system. Furthermore, radiologists would need to be trained in the acquisition and interpretation of the data and the large amount of data generated would significantly increase the amount of time radiologists need to spend analyzing the data. Several experts suggested that the cost-benefit ratio of DBT may reduce the willingness of clinicians to adopt this technology. It may also affect payer decisions to reimburse the use of the technology.

MarginProbe System for Intraoperative Identification of Positive Margins During Breast Cancer Lumpectomy

Successful breast-conserving surgery for early-stage breast cancer requires that the margins around the tissue excised during lumpectomy have cancer-free margins. Many patients who undergo a breast-conserving procedure require a second surgery when postsurgical histopathology identifies that surgical margins are positive for cancer or cancer-free surgical margins are of insufficient depth. A recent observational study of reexcision rates after breast conservation surgery at four institutions calculated an overall reexcision rate of 22.9% and noted that previous studies had reported reexcision rates ranging from 30% to 60%.[25]

The MarginProbe™ System (Dune Medical Devices, Ltd., Caesarea, Israel) is intended for intraoperative assessment of lumpectomy margins to enable breast cancer surgeons to resect additional tissue from positive margins during lumpectomy rather than performing a second procedure at a later date.[26]

The system uses radiofrequency (RF) spectroscopy, in which tissue is subjected to an electromagnetic field to measure its response to stimulation.[27] Research findings suggest that RF spectroscopy can differentiate between normal and cancerous tissue based on bioelectric differences between the two tissues.[28] These differences may be due in part to changes in the cellular and tissue structure of cancer, including cell membrane depolarization, altered cell nucleus morphology, increased vascularity, and loss of cell-cell adhesion.[27] Because RF spectroscopy detects only tissue response to the electromagnetic field near the surface of the sample, it is considered appropriate for detecting clean margins, often defined as a depth of normal (noncancerous) tissue of at least 1–2 mm.[28] The system incorporates a diagnostic algorithm, based on a large number of comparisons between RF spectroscopy readings and pathology results, to differentiate between cancerous and noncancerous tissue.[29] The system provides a binary answer indicating whether the assessed margin is clean.

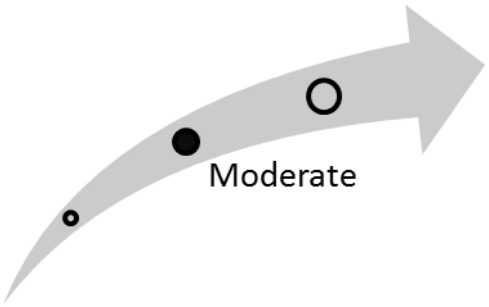
In a late-phase, clinical trial, the system was used to assess tissue excised from 664 women undergoing a lumpectomy procedure to treat nonpalpable malignant lesions that required image-guided localization.[30] Patients were randomly assigned to receive standard of care intraoperative assessment of whether to resect additional tissue or standard of care assessment plus assessment using the system.[30] The primary endpoint was the rate of complete surgical resection (CSR) defined as intraoperative identification of all positive margins and resection of such margins during the lumpectomy procedure.[26] Preliminary results reported by the manufacturer indicated that the rate of CSR was significantly improved in the MarginProbe arm compared with the control arm (72% [117/163] vs. 22% [33/147], $p < 0.0001$).[30] This increase in intraoperative identification of positive margins was reported to have led to an approximate 50% reduction in the reexcision rate (5.6% reexcision rate in the MarginProbe arm compared with 12.7% in the standard of care arm).[30] Additionally, the volume of tissue dissected in each arm was comparable; 93 cc in the MarginProbe arm compared with 85 cc in the control arm.[30]

In May 2011, Dune Medical announced that FDA had formally accepted the company's premarket approval (PMA) application for the system, which was based on the above trial results.[31] Given that no device is FDA approved for intraoperative assessment of lumpectomy margins, FDA granted the MarginProbe System priority review; the General and Plastic Surgery Devices Panel of the Medical Devices Advisory Committee was scheduled to discuss the MarginProbe application on June 21, 2012.[31,32]

Clinical Pathway at Point of This Intervention

The primary treatment for patients in whom early stage breast cancer (e.g., ductal carcinoma in situ, stage I or II invasive carcinoma of the breast) has been diagnosed is surgical resection of the cancerous tissue. Depending on the stage and level of lymph node involvement, patients may undergo breast-conserving surgery (e.g., lumpectomy) or mastectomy.[33] Alternatively, patients who meet all criteria for breast-conserving surgery except that their tumor is too large may undergo neoadjuvant chemotherapy to reduce tumor size.[33] Following surgical resection, histologic analysis of the resected tissue is performed to assess characteristics of the tumor that may influence subsequent treatment. In particular, lumpectomy samples are tested to assess whether the margins of resected tissue are cancer free.[33] Patients with cancer-positive margins may undergo a subsequent surgical resection to remove additional tissue and establish cancer-free margins. Following lumpectomy, patients are typically treated with radiation therapy or adjuvant systemic therapy (e.g., hormone therapy, chemotherapy) in an attempt to eradicate remaining cancer cells.[33] If approved, the MarginProbe System would be used during lumpectomy to assess whether lumpectomy margins are cancer free, potentially reducing the need for subsequent surgical procedures.

Figure 2. Overall High Impact Potential: MarginProbe System for intraoperative identification of positive margins during breast cancer lumpectomy



Overall, experts commenting on this intervention believe that a significant unmet need exists for a technology that could rapidly and objectively identify positive margins during breast-conserving surgery, which could significantly reduce the morbidity and costs associated with performing secondary surgeries in this patient population. While initial results for the MarginProbe system were viewed as promising with limited potential to negatively affect patient outcomes, most experts believe that additional data would be needed before widespread adoption. Based on this input, our overall assessment is that this intervention is in the moderate high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, and health systems backgrounds, offered perspectives on this intervention.[34-40] The majority of experts agreed that a significant unmet need exists for a technology or methodology that can rapidly assess the margins of excised breast tissue to determine whether further tissue resection is necessary. Experts cited the large number of patients who require a second surgery following the identification of positive margins during post-surgical histological analysis and the adverse health effects associated with undergoing a second surgical procedure.

While experts suggested that filling this unmet need could moderately improve health outcomes for patients by reducing the complications and stress associated with the need to undergo a second lumpectomy or mastectomy, experts were less certain regarding the potential for the MarginProbe System to improve long-term survival for patients with breast cancer. Additionally, experts

questioned whether the evidence base for the MarginProbe System was sufficient to suggest that it could meet the unmet need. One expert with a research background questioned whether the sensitivity and specificity was sufficient to significantly improve reexcision rates.

The majority of experts did not think that adoption of the MarginProbe system would have a significant impact on health disparities. One expert with a clinical perspective suggested that the system might create a slight increase in health disparities if it were to be offered exclusively at large/high-volume breast cancer centers. Conversely, an expert with a clinical perspective suggested that the system could modestly decrease disparities if it allowed less specialized surgeons to perform breast-conserving surgery in undeserved regions of the country.

Experts agreed that adoption of the system would have minimal impact on health care system staffing and infrastructure. Potential changes such as the need to acquire the system itself, a slight shift in operating room demand due to a small increase in the duration of breast-conservation surgery procedures, and a potential reduction in the number of second surgeries were seen as incremental. Additionally, experts did not think that use of the system would have a significant impact on patient management because patients would follow the same clinical pathway with or without the intraoperative screening with the device.

The majority of experts believe that if final results from the most recent clinical trial of the MarginProbe system demonstrate a clear improvement in the intraoperative detection of positive margins, physicians and patients would rapidly adopt its use to avoid complications associated with reexcision procedures. However, the majority of reviewers felt that more data on the impact of the system on patients with breast cancer would be needed before widespread adoption. Experts also noted that physicians would have to undergo a learning curve in the real-world application of the system; however, multiple clinicians noted that the training required in the use of the device appears likely to be minimal. In terms of patient adoption, experts suggested that the lack of side effects and minimal impact on the patient's care would increase the likelihood for patient adoption.

The majority of experts suggested that the system could have a significant impact by reducing costs associated with breast-conserving surgery. While initial acquisition of the system and intraoperative use of the system would likely increase costs, experts suggested that this increase could be outweighed by a reduction in secondary surgery procedures.

mTOR Inhibitor (Everolimus) for Treatment of Breast Cancer

The mammalian target of rapamycin (mTOR) plays a central role in a cell-signaling pathway regulating multiple cancer-related processes such as cell growth, proliferation, survival, and migration.[41] Additionally, multiple mTOR pathway molecules have been shown to be aberrantly expressed and/or mutated in various cancers, suggesting that mTOR inhibitors could function as anticancer agents.[41] Based on this observation, a class of drugs that inhibit mTOR via a mechanism of action similar to that of the naturally occurring macrolide antibiotic rapamycin (also known as sirolimus) has been developed.[41] Rapamycin-like mTOR inhibitors have been approved for treating various cancers, including temsirolimus (Torisel®) for treating renal cell carcinoma[42] and everolimus (Afinitor®) for treating renal cell carcinoma, subependymal giant cell astrocytoma associated with tuberous sclerosis, and pancreatic neuroendocrine tumors.[43]

Given mTOR's central role in multiple cancer-related cellular processes, mTOR inhibition may represent a viable treatment modality in a wide range of tumor types, and many clinical trials are ongoing in various cancer indications. One potential mTOR inhibitor indication that has reached late stages of development is the treatment of estrogen receptor (ER)-positive breast cancer.[44]

ER-positive metastatic breast cancer often responds to treatment with endocrine therapy; however, most patients' cancers will develop resistance to front-line endocrine therapy.[45] Multiple mechanisms of developing resistance to endocrine therapy have been identified, including signaling through the mTOR/phosphatidylinositol-3 kinase (PI3K) pathway.[46] Everolimus is being tested as an adjunct to the steroidal aromatase inhibitor exemestane in treating patients whose disease has progressed following treatment with a nonsteroidal aromatase inhibitor (e.g., anastrozole, letrozole).[44] Preliminary results from a randomized, double-blind, placebo-controlled clinical trial of 705 patients (BOLERO-2) were recently published.[47] Everolimus (10 mg, daily) met its primary endpoint of improving progression-free survival as determined by investigator assessment (6.9 months vs. 2.8 months; hazard ratio, 0.43; $p < 0.0001$).[47] Additional late-phase studies of everolimus for use in other breast cancer indications are ongoing.[48,49] An earlier study investigating a combination of another mTOR inhibitor (temsirolimus) and letrozole for first-line treatment of ER-positive metastatic breast cancer was discontinued after an interim analysis showed that adding temsirolimus to letrozole was unlikely to improve efficacy, demonstrating that even within cancer types, subgroups of patients who do or do not respond to a class of therapy exist.[50]

As a drug class, rapamycin-like mTOR inhibitors have been relatively well tolerated by patients. The prescribing information for approved compounds lists the most common side effects as anorexia, asthenia, edema, rash, mucositis, and nausea for temsirolimus and abdominal pain, diarrhea, edema, fatigue, fever, headache, nausea, rash, and stomatitis for everolimus.[42,43] mTOR inhibition is also associated with renal failure, elevated blood glucose and lipids, and immunosuppression, which can lead to increased risk of infections.[42,43]

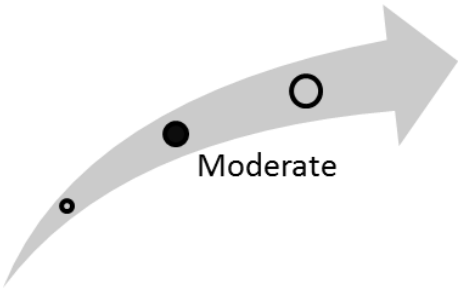
Regulatory filings for the use of everolimus in ER-positive breast cancer were submitted to FDA in late 2011, and a decision was anticipated in 2012.[51] However, since everolimus is available as an approved therapy for other cancers (e.g., renal cell carcinoma), physicians may opt to prescribe the drug off-label before any FDA approval of a breast cancer indication. A query of an online pharmacy identified a retail price of about $9,000 per month for everolimus.[52]

Clinical Pathway at Point of This Intervention

Patients in whom locally advanced/metastatic ER-positive breast cancer has been diagnosed are typically treated with endocrine therapy using aromatase inhibitors or antiestrogens and may

undergo multiple rounds of endocrine therapy.[33] However, a subset of patients with symptomatic disease may be considered for initial treatment with cytotoxic chemotherapy.[33] Patients in whom HER2-negative disease is deemed to have become refractory to endocrine therapy are typically treated with one of several cytotoxic chemotherapy regimens.[33] Everolimus is being tested as an adjunct to the steroidal aromatase inhibitor exemestane in treating patients whose disease has progressed following treatment with a nonsteroidal aromatase inhibitor (e.g., anastrozole, letrozole).[44]

Figure 3. Overall High Impact Potential: mTOR inhibitor (everolimus) for treatment of breast cancer



Experts commenting on this intervention suggested that results for progression-free survival in endocrine-therapy-resistant, metastatic breast cancer were promising for a condition with few treatment options. Experts were anxious to see data showing that the observed improvement in progression-free survival translated to improved overall survival before claiming that mTOR inhibitors would have a large impact on patient outcomes. Based on this input, our overall assessment is that this intervention is in the moderate high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, and health systems backgrounds, offered perspectives on the topic of everolimus for treating ER-positive breast cancer.[53-59] Experts viewed the unmet need for improved treatments for ER-positive breast cancer resistant to first-line endocrine therapy as moderately to very important, citing the fact that the majority of breast cancers are ER-positive and that most patients with metastatic disease will eventually develop resistance to hormone therapy. Additionally, experts noted that patients with ER-positive metastatic breast cancer resistant to endocrine therapy have a poor prognosis and few treatment options aside from cytotoxic chemotherapy.

The majority of experts believe that everolimus has some potential to improve patient health outcomes. While experts believe that the progression-free survival benefit demonstrated in the BOLERO-2 trial is significant and suggested that the treatment would likely improve overall survival, experts believe that any extension of overall survival would likely be of short duration. One expert with a clinical perspective noted that the toxicity of adding everolimus to endocrine therapy can be significant, citing the five-times-higher rate of treatment discontinuation reported in the everolimus arm of the BOLERO-2 trial. This clinical expert also noted that this positive result for use of an mTOR inhibitor in breast cancer would need to be balanced against the prior negative result for temsirolimus, but left open the possibility that patients with hormone-refractory disease represent a subpopulation likely to respond to mTOR inhibition.

Experts suggested that both physicians and patients would likely use everolimus in treating endocrine therapy-resistant breast cancer because of its potential to increase progression-free survival, its oral route of administration, and a manageable side effect profile relative to cytotoxic

chemotherapy. However, several experts noted that the use of everolimus in this setting has not demonstrated an overall survival benefit, which some physicians and patients would like to see before adopting treatment.

The majority of experts suggested that use of everolimus to treat endocrine therapy-resistant breast cancer would lead to a moderate increase in treatment costs. One expert with a clinical perspective noted that if combined treatment with everolimus and exemestane is effective in delaying disease progression, a relatively large population of patients with slowly progressing endocrine therapy-resistant breast cancer could undergo extended treatment with the combination. Two experts, with clinical and research perspectives, suggested that some controversy regarding cost of this therapy could arise if it ultimately fails to demonstrate a significant improvement in overall survival.

Experts did not think that the use of everolimus would have a significant impact on health disparities. However, several experts suggested that an oral route of administration could allow a minor reduction in health disparities if patients located in remote locations could avoid the need to travel to cancer centers to receive chemotherapy infusions.

As an orally administered medication, everolimus was not anticipated by experts to cause significant shifts in health care staffing or infrastructure or require significant changes to the management of patients who would already be closely monitored for disease progression.

Novel HER2-Targeted Therapies for Breast Cancer

HER2-positive breast cancer is a subclass of invasive breast cancer characterized by the expression of high levels of the epidermal growth factor receptor (EGFR) family member HER2 and comprises approximately 20% of breast cancer cases.[60] Historically, HER2-positive breast cancer has been associated with more aggressive disease and poor outcomes.[60] While the treatment of HER2-positive breast cancer has improved with the availability of HER2-targeted therapies such as the HER2-specific monoclonal antibody trastuzumab (Herceptin®) and the HER2 kinase inhibitor lapatinib (Tykerb®), many patients' cancers still fail to respond to or progress with these treatments, and compounds with improved efficacy and/or efficacy against resistant disease are highly desired.[61] Two novel biologic therapies are in late-stage clinical trials for treating HER2-positive breast cancer: trastuzumab emtansine and pertuzumab (Omnitarg®).

Trastuzumab emtansine (formerly called trastuzumab-DM1), an antibody-drug conjugate (ADC), is an investigational biologic that couples a HER2-specific monoclonal antibody (trastuzumab) to a potent chemotherapeutic agent, the microtubule assembly inhibitor emtansine (DM1).[62] The antibody and drug are coupled in such a way that emtansine is held in a stable inactive form outside of the cell; only upon cellular uptake of the drug conjugate mediated by the antibody's binding to the HER2 receptor is emtansine released and activated.[62] In this way, the cytotoxic activity of emtansine is targeted to cells expressing the HER2 receptor, preferentially targeting tumor cells (which express high levels of HER2) and sparing many normal tissues from the toxic effects of the drug. Preclinical studies have demonstrated that trastuzumab emtansine retains the antiproliferative activity of trastuzumab, and the cytotoxic activity of emtansine may endow the compound with additional antitumor properties even in tumors that have become independent of HER2 signaling (a hallmark of some tumors that have become resistant to trastuzumab and/or lapatinib).[61]

Preliminary evidence for the activity of trastuzumab emtansine came from a phase II trial treating patients with metastatic HER2-positive breast cancer that had progressed following treatment with trastuzumab-based and lapatinib-based chemotherapy regimens.[63] In this single-arm trial of 100 heavily pretreated patients, trastuzumab emtansine resulted in an objective tumor response in 33% of patients.[63] Additionally, its developer recently announced that a second phase II trial of 120 patients in the first-line treatment of metastatic disease demonstrated that trastuzumab emtansine as compared with trastuzumab plus docetaxel resulted a significant increase in the duration of progression-free survival (14.2 months vs. 9.2 months; hazard ratio, 0.59).[64] The company reported that fewer severe adverse events were reported in the trastuzumab emtansine arm than the trastuzumab plus docetaxel arm; grade 3 or higher adverse events were reported by 46.4% of patients and 89.4% of patients in the trastuzumab emtansine and trastuzumab plus docetaxel arms, respectively.[64] Roche recently announced that the phase III EMILIA trial of trastuzumab emtansine monotherapy in the second-line setting had met its primary endpoint of improving progression-free survival compared with a standard second-line therapy (lapatinib plus systemic chemotherapy [capecitabine]).[65] Additional phase III trials in the first-line and third-line setting are ongoing.

Trastuzumab emtansine is being developed by F. Hoffmann-La Roche, Ltd., Basel, Switzerland.[66] In 2010, Roche submitted a biologic license application to FDA for use of trastuzumab emtansine as third-line treatment, based on results from the initial phase II trial.[67] However, FDA issued Roche a refuse-to-file letter stating that the trial did not meet the standards for accelerated approval because all potential available treatment options had not been exhausted in

the patient population under study.[67] Based on the results of the EMILIA trial, Roche believes that it can complete a regulatory filing for trastuzumab emtansine in the second-line setting before the end of 2012.[66]

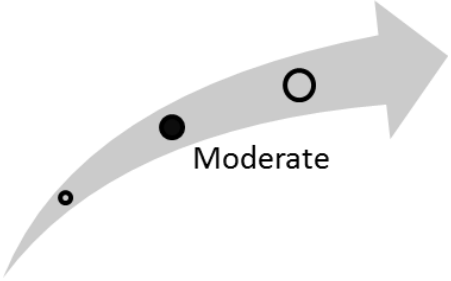
Like trastuzumab, pertuzumab (also being developed by Roche) is a monoclonal antibody specific for the HER2 protein; however, it is purported to inhibit HER2 activity through a mechanism of action different from that of trastuzumab and may act synergistically with trastuzumab treatment.[68] Specifically, pertuzumab is intended to block the dimerization of HER2 with HER family receptor tyrosine kinases (e.g., homodimerization with HER2, heterodimerization with HER3), which is required for receptor tyrosine kinase activation.[69] Pertuzumab is also under study in multiple disease settings including adjuvant therapy for localized disease and first-line treatment for metastatic disease. The developer recently announced positive results from the phase III CLEOPATRA study, which demonstrated that a combination of trastuzumab, docetaxel, and pertuzumab extended progression-free survival compared with trastuzumab, docetaxel, and placebo in chemotherapy-naïve patients with metastatic breast cancer.[68] Preliminary results from the trial indicated that adding pertuzumab to a standard first-line therapy for metastatic HER2-positive breast cancer (trastuzumab plus docetaxel) extended progression-free survival by an average of 6.1 months (18.5 months in the pertuzumab group vs. 12.4 months in the control group).[70]

Based on the results of the CLEOPATRA study, a biologics license application has been submitted to FDA and was granted priority review status in February 2012, suggesting that, if approved, pertuzumab could become available before the end of 2012.[71]

Clinical Pathway at Point of This Intervention

Patients with HER2-positive breast cancer that has become metastatic or locally advanced and untreatable by surgical resection are typically treated using a series of HER2-targeted therapies. Standard first-line therapy typically includes treatment with trastuzumab plus a single cytotoxic chemotherapy agent (e.g., capecitabine, docetaxel, paclitaxel, vinorelbine).[33] Patients whose disease progresses following first-line therapy are typically treated with a second HER2-targeted therapy, typically lapatinib plus capecitabine.[33] Alternative second-line chemotherapy options include trastuzumab plus a cytotoxic agent that was not used in first-line treatment or trastuzumab plus lapatinib.[33] The most advanced phase III clinical trial of trastuzumab emtansine is studying the drug as a second-line treatment option that could displace the use of current treatments. The most advanced phase III clinical trial of pertuzumab is studying the drug as a first-line treatment that would be used in addition to standard first-line therapy.

Figure 4. Overall High Impact Potential: Trastuzumab emtansine for treatment of breast cancer



Overall, experts commenting on these interventions believe that trastuzumab emtansine and pertuzumab have significant potential to incrementally improve on existing HER2-positive metastatic breast cancer treatments, the shortcomings of which they thought represented a

significant unmet need. Experts also thought that trastuzumab emtansine's potential to displace current standard-of-care treatments for HER2-positive metastatic breast cancer and likely high cost of both trastuzumab emtansine and pertuzumab could have significant impacts on the management of these patients. Based on this input, our overall assessment is that these interventions are in the moderate high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, and health systems backgrounds, offered perspectives on trastuzumab emtansine for treating breast cancer.[72-78] Seven experts, with clinical, research, and health systems backgrounds, offered perspectives on pertuzumab for treating breast cancer.[79-85] It should be noted that experts provided comments on these interventions before the recent release of phase III data. At the time of review, Roche had not yet announced that the phase III trial of trastuzumab emtansine in second-line treatment of metastatic breast cancer had met its primary endpoint. Similarly, although Roche had announced that the phase III trial of pertuzumab in first-line treatment of metastatic breast cancer had met its primary endpoint, the magnitude of the improvement in progression-free survival had not yet been released.

The majority of experts agreed that a significant unmet need exists for improved treatments of HER2-positive metastatic breast cancer, citing the fact that many patients have disease that is refractory to current therapies and/or progresses during therapy. Although experts believe the overall unmet need in HER2-positive breast cancer is large, they were less enthusiastic about the use of these novel agents in salvage settings following treatment with multiple initial regimens.

Based on the results of the phase II trials, the majority of experts thought that trastuzumab emtansine has moderate to large potential to improve patient health. Experts thought that the phase II trial results suggested that trastuzumab emtansine might improve on both the efficacy (i.e., ability to improve progression-free survival) and safety of current HER2-targeted therapies; however, experts seemed to believe that the improvements relative to the efficacy of current treatments for HER2-positive metastatic disease would likely be incremental, especially in the third-line refractory disease setting. Multiple experts noted that if trastuzumab emtansine were shown to improve outcomes in the first-line metastatic disease or adjuvant setting, it could have a more significant impact on HER2-positive disease treatment models.

Similarly, the majority of experts thought that pertuzumab has moderate to large potential to improve patient health, citing the preliminary signals of activity in the neoadjuvant setting (i.e., presurgical treatment of localized disease) and heavily pretreated patients. Two experts (both with a research perspective) thought that pertuzumab has only minimal potential to improve patient health, suggesting that the addition of pertuzumab to current treatment of HER2-positive breast cancer would represent only an incremental improvement on existing therapies. Multiple experts mentioned the potential for cardiac toxicity known to be associated with trastuzumab treatment and suggested that further study of the drug would need to rule out the possibility of cumulative heart damage due to multiple antibodies simultaneously targeting HER2 or prolonged duration of anti-HER2 therapy.

Because health care workers would administer trastuzumab emtansine and pertuzumab in the same manner as existing HER2-targeted therapies (e.g., trastuzumab), experts did not think that adoption of the drugs would require significant changes in health care facility staffing, or infrastructure. As such, experts saw few obstacles to patients or physicians adopting the use of trastuzumab emtansine and pertuzumab. One potential obstacle raised by experts was the likely high cost of trastuzumab emtansine and pertuzumab, which could affect patient out-of-pocket costs.

Additionally, experts noted that the likely high cost of these drugs has the potential to be controversial in terms of the cost-benefit ratio and also has the potential to increase health disparities.

Colorectal Cancer Interventions

Concomitant Colorectal Cancer Screening and Annual Influenza Vaccine (FLU-FOBT) Program

Colorectal cancer (CRC) is the third most common cancer diagnosed in the United States.[86] CRC tends to be slow to develop, and precancerous lesions and early stage CRCs can typically be treated successfully by surgical resection. Therefore, successful CRC screening programs could mitigate much of the morbidity and mortality associated with this condition. However, with current screening options, only a minority of the population adheres to CRC screening guidelines, and about half of CRCs diagnosed in the United States are diagnosed at late disease stages.[86,87] Therefore, programs, such as FLU-FOBT (fecal occult blood testing), that have the potential to improve CRC screening rates are highly sought.

Multiple barriers to CRC screening have been cited, including patient-specific barriers and health care system barriers.[88] Patient-specific barriers include lack of patient awareness of the screening benefits and recommendations, embarrassment over the nature of screening methods, anxiety regarding screening, and cost of screening, especially for patients lacking health insurance coverage.[89] Health care system barriers include the lack of time to address all aspects of a patient's health during primary care appointments, a lack of reminders that a patient is due for screening, an inability to track down dates of prior screening, and long delays in colonoscopy scheduling and/or lack of direct access to colonoscopy.[90]

One proposed solution to the problem of finding a method to provide timely and routinized CRC screening is the pairing of FOBT or fecal immunochemical testing (FIT) with annual influenza immunization.[88] Influenza immunization and FOBT/FIT share several attributes that could make them highly complementary: both are recommended to be performed annually and both are, at least in part, targeted to elderly patients. The University of California, San Francisco (UCSF) has implemented multiple versions of this program within various settings, including influenza vaccine clinics (both hospital-based and managed-care-based), pharmacy-based influenza vaccination campaigns, community health care clinics, and primary care centers.[88,91-94]

Hallmarks of the UCSF studies included the following: provision of home FOBT/FIT kits to patients whose medical records indicated that they were due for CRC screening, provision of a multilingual information pamphlet on the benefits of CRC screening, training of health care workers in culturally sensitive discussion of CRC screening, and followup telephone calls to patients who had received FOBT/FIT test kits, but not returned samples.[88]

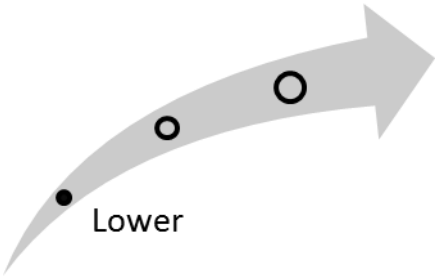
In the largest test of the concept to date, patients obtaining influenza vaccinations at a high-volume influenza clinic run by a managed care organization were randomly assigned to receive either the influenza vaccination alone (n=4,653) or the influenza vaccine as well as an FIT test kit (n=2,182). Within 3 months of their visit to the influenza clinic, 13.7% of patients in the influenza vaccine-only cohort completed a FIT test compared with 30.3% of patients in the influenza vaccine plus FIT test kit cohort. The percentage of patients adhering to CRC screening recommendations went from 51.5% to 56.3% in the influenza-only group compared with 49.2% to 63.2% in the influenza vaccine plus FIT test kit cohort ($p < 0.0001$ for the change difference between cohorts).[91]

Current Approach to Care

Several options are used for routine CRC screening in the general population that has an average risk of developing CRC. These include annual FOBTs, sigmoidoscopy every 5 years, double-contrast barium enema every 5 years, CT colonography every 5 years, or colonoscopy every 10 years.[95,96] Patients typically engage the health care system during primary care visits, during which

caregivers can advise patients of the potential benefits of CRC screening.[88] Additionally, national campaigns such as the U.S. Centers for Disease Control and Prevention's Screen for Life program disseminate information on CRC that may influence an individual's decision to seek CRC screening.[87]

Figure 5. Overall High Impact Potential: Concomitant colorectal cancer screening and annual influenza vaccine (FLU-FOBT) program



Experts who commented on this topic believe that it has an interesting approach to increasing CRC screening rates that has significant potential to improve screening adherence in certain settings. However, experts questioned whether such a program would be able to be implemented on a large scale, thereby limiting their view of its overall potential for high impact. Based on this input, our overall assessment is that this intervention is in the lower end of the high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, health systems, and health administration backgrounds, provided perspectives on this topic.[97-103] Experts were of the opinion that programs linking routine CRC screening with the annual administration of influenza vaccines have the potential to address a moderately to very important unmet need, citing low adherence rates to CRC screening guidelines in spite of evidence of their ability to reduce CRC-associated mortality. However, several experts noted that the ability of such a program to reach unscreened patients could be limited by the extent to which patients who are not compliant with CRC screening seek annual influenza vaccination. In this vein, experts noted that patients seeking prophylactic vaccination for influenza might be more likely than the average patient to already be adhering to preventive screening measures such as CRC screening. However, to the extent that patients who were not up to date with CRC screening were reached by such a program, it has significant potential to improve CRC screening rates and, therefore, improve patient health, experts thought.

Experts were divided on the issue of whether the FLU-FOBT program has potential to improve health disparities. Those who thought the program could improve disparities cited the emphasis placed on cultural sensitivity in the pilot programs, which could influence patients in certain underserved populations who previously resisted discussing or undergoing CRC screening to do so. These experts also noted the diversity of settings in which the program was offered (e.g., managed care clinics, pharmacies, community health care clinics), which could reach some underserved patients who do not routinely see a primary care physician. Conversely, experts who did not think the FLU-FOBT program would have a significant impact on health disparities questioned whether patients who typically resist undergoing CRC screening could be convinced to do so and suggested that fewer patients in traditionally underserved populations would routinely seek vaccination against influenza.

While implementing the FLU-FOBT program could shift the care setting for disseminating information about CRC screening and would necessitate some training of health care facility staff, it would not likely have a significant impact on health care infrastructure or patient management, experts believe. However, multiple experts noted the need to follow up with patients receiving positive results from noninvasive tests, which could represent a significant shift in the way patients are otherwise managed, especially for FLU-FOBT programs implemented in settings that are not associated with a gastroenterologist (e.g., pharmacies).

Experts disagreed on whether health care workers would accept and adopt the implementation of a FLU-FOBT program. While some experts suggested that clinicians would welcome an innovation that might increase CRC screening rates, others suggested that clinicians may not want to spend the time providing information about CRC screening in what are presumably high-volume settings. Additionally, several experts noted that patients often fail to return FOBT test kits, and health care systems might not want to allocate time and resources to follow up with patients to encourage them to return the kits.

Methylated Septin 9 Blood Test for Colorectal Cancer Screening

CRC is the third most common cancer diagnosed in the United States.[86] CRC tends to be slow to develop, and precancerous lesions and early stage CRCs can typically be treated successfully by surgical resection. Therefore, successful CRC screening programs could mitigate much of the morbidity and mortality associated with this condition. However, with current screening options, only a minority of the population adheres to CRC screening guidelines, and about 50% of CRCs diagnosed in the United States are diagnosed at late disease stages.[86] Therefore, new screening methodologies that could increase the percentage of the population that undergoes recommended CRC screening are highly sought.

Research has demonstrated that cells undergo a range of epigenetic modifications (e.g., DNA methylation) during transformation to cancerous cells.[104] Additionally, elevated levels of methylated DNA have been found in the blood of patients with CRC, and it could serve as a readily accessible marker for cancer screening.[104] One methylated DNA species that has been shown to be present specifically in the blood of individuals with CRC is a methylated form of the *Septin 9* gene, detection of which is being studied as a potential colon cancer screening test.[104] Like other noninvasive colon cancer tests (e.g., FOBT), a positive result from the methylated Septin 9 test would require that the patient undergo a colonoscopy to confirm the result and resect any precancerous or cancerous lesions.[105]

A methylated Septin 9 DNA blood test is being developed by Epigenomics AG (Berlin, Germany). In December 2011, Epigenomics released initial data from a trial in which a subset of 7,940 patients undergoing colonoscopy screening were also tested with the Epigenomics Septin 9 test.[106,107] Blood samples were collected from all patients who subsequently underwent colonoscopy for determination of CRC status. A subset of these samples were tested using the Epi proColon 2.0 blood test. Tested samples included those from all 50 patients with CRC, all 650 patients with advanced adenomas, a random subset of 450 patients with small polyps, and a random subset of 450 patients with no evidence of CRC. Preliminary results indicated that, compared with CRC detection by colonoscopy, the Septin 9 test had a sensitivity of 68% and a specificity of 80%.[107] Data on the test's ability to detect precancerous adenomatous polyps were not presented.

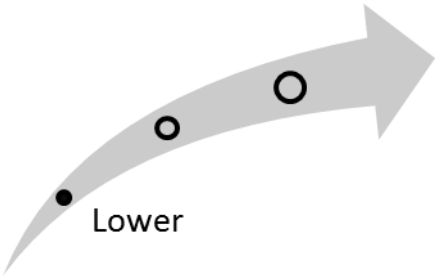
In December 2011, Epigenomics submitted the first portion of a modular premarket approval application (PMA) to FDA with the intention of completing the PMA application by the end of 2012.[108] Besides submitting the available data, Epigenomics will include a recently initiated head-to-head trial (NCT01580540) of Epi proColon 2.0 and fecal immunochemical testing (FIT) designed to demonstrate noninferiority of the Epi proColon 2.0 test in the final PMA submission, the company has said.[107,109]

Clinical Pathway at Point of This Intervention

Several options are available for routine CRC screening in patients with an average risk of developing colon cancer, including annual FOBTs, sigmoidoscopy every 5 years, double-contrast barium enema every 5 years, CT colonography every 5 years, or colonoscopy every 10 years.[95,96] For noncolonoscopy tests, positive results require a subsequent colonoscopy to confirm the result and perform any required biopsy of suspicious polyps.[95] Septin 9 blood testing would be another routine screening option that, like other noncolonoscopic methods, would require a followup colonoscopy for positive result confirmation and lesion excision.[105] Information on the test states that it is not intended to substitute for colonoscopy; however, it might be useful as a complement to

colonoscopy or for use in individuals unwilling or unable to undergo colonoscopy.[110] It might also be useful screening for individuals also unwilling or unable to undergo colonography.

Figure 6. Overall High Impact Potential: Methylated Septin 9 blood test for colorectal cancer screening



Overall, most experts commenting on this intervention thought that an accurate blood-based CRC screening test obtained through venipuncture (rather than testing a stool sample) could fundamentally change CRC screening practices by increasing the percentage of patients screened for CRC. However, regarding the Epi proColon 2.0 test specifically, experts were more cautious, questioning whether the reported sensitivity and specificity of the test were high enough and whether the likely high cost of the test relative to other noninvasive options such as FOBTs would prevent its widespread adoption. Based on this input, our overall assessment is that this intervention is in the lower end of the high-potential-impact range.

Results and Discussion of Comments

Seven experts with clinical, research, health systems, and health administration backgrounds, offered perspectives on this topic.[111-117] The majority of experts thought that a blood-based screening technology has the potential to address a significant unmet need, citing the current lack of a blood-based screening test and the low rate of adherence to recommended screening (i.e., fecal sample testing, colonoscopy, colonography) that may be due in part to discomfort with current test methods. One researcher saw a more limited unmet need, stating that multiple noninvasive tests are already available for CRC and that the Septin 9 test would only provide another such option. Other experts saw more significance in the blood-based nature of the test, stating that it would likely be more acceptable to patients than current noninvasive fecal-based tests and that patients who had not been willing to undergo screening might do so. Additionally, multiple experts noted that the blood-based nature of the test could allow its incorporation into routine blood tests (e.g., cholesterol screening). In this way, experts envisioned the potential for the septin 9 blood test to shift patterns of patient management significantly by allowing primary care physicians to incorporate noninvasive colorectal cancer screening into routine care rather than requiring patients to return fecal samples collected in the home setting. Based on the potential that a blood-based test could increase screening rates (particularly among individuals who are not undergoing any screening) experts believe that the septin 9 screening test could lead to significant improvement in patient health outcomes. However, multiple experts expressed concern regarding the reported sensitivity and specificity of the Epi proColon test and noted that false-negative results of the septin 9 test could lead to significant disease progression before detection. One expert with a clinical perspective suggested that the potential for false-negative results could be most relevant if some patients opt for the convenience of an available blood test over colonoscopy.

The majority of experts noted that the septin 9 test was significantly more expensive than noninvasive fecal tests (e.g., FOBT, FIT). While the frequency with which the septin 9 test would need to be performed has not yet been determined, multiple experts suggested that screening a large number of patients with the septin 9 test would significantly increase the cost of CRC screening. Ultimately cost- effectiveness studies would be needed to determine whether sufficient numbers of treatable CRCs could be identified to offset the cost of screening.

Glioblastoma Intervention

Tumor-Treating Fields Therapy (NovoTTF-100A) for Glioblastoma Multiforme

Patients in whom glioblastoma multiforme (the most common form of brain cancer) has been diagnosed have a very poor prognosis and patient quality of life is low during the course of treatment.[118] Tumor-treating fields (TTF) therapy (NovoTTF-100A™, NovoCure, Ltd., St. Helier, Jersey Isle) is a new, noninvasive technology that is intended to treat glioblastoma on an outpatient basis using electrical fields. The technology was FDA approved in April 2011 for treating glioblastoma multiforme after surgical and radiation treatments have failed. [118] It is also under study for nonsmall cell lung cancer (NSCLC).

TTF therapy exposes cancer cells to alternating electric fields of low intensity and intermediate frequency, which are purported to both selectively inhibit tumor growth and reduce tumor angiogenesis.[119] Tumor-treating fields are proposed to inhibit rapidly dividing tumor cells by two mechanisms:[120]

- During formation of the mitotic spindle, which is necessary for proper chromosome segregation and progression through mitosis, highly polarized subunits (tubulin monomers) that make up the mitotic spindle become aligned with the electric field, inhibiting their incorporation into the growing spindle.
- During cell division (cytokinesis), the formation of the cleavage furrow results in a nonuniform, electric field in the cell, which causes charged and polar molecules to aggregate at the cleavage furrow. This aggregation can lead to disruption of cell division and cell death.

TTF therapy is delivered by a battery-powered, portable device that generates the fields via disposable electrodes that are noninvasively attached to the patient's shaved scalp (in the case of glioblastoma) over the site of the tumor. The device is used by the patient at home on a continuous basis (20–24 hours per day) for the duration of treatment, which can last for several months. Patients can carry the device in a backpack or shoulder pack while carrying out activities of daily living.[120,121]

The FDA approval was based on results of a 237-patient randomized, controlled trial comparing TTF to the clinician's (and patient's) chemotherapy of choice. No statistically significant difference in any outcomes were noted between the groups. Patients in the TTF arm of the trial had overall median survival of 6.6 months (n=120) compared with a median 6.1 months (n=117) for chemotherapy patients.[118] Patients in the TTF arm reported fewer side effects (e.g., less nausea, vomiting) and improved quality of life than patients in the chemotherapy arm.[118]

The NovoTTF-100A device is available at a small number of clinical centers of excellence at which clinicians have received training in the device's use.[122] A survey of 11 major, private, third-party payers that publish their policies online (i.e., Aetna, Anthem, Blue Cross/Blue Shield Alabama, Blue Cross/Blue Shield Massachusetts, CIGNA, HealthPartners, Humana, Medica, Regence, Wellmark, United Healthcare) identified only 2 third-party payers with policies specific to tumor treating fields; both payers consider tumor treating fields to be investigational at this time.[123,124]

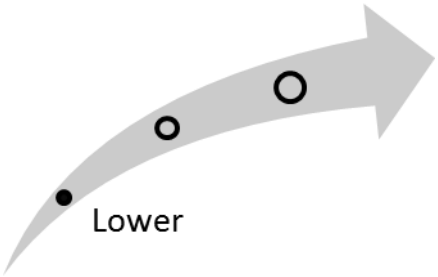
TTF therapy continues to undergo study as a treatment for newly diagnosed glioblastoma multiforme in combination with maintenance temozolomide following debulking surgery and chemoradiation therapy.[125] A second version of the device based on the same technology is under

study as a second-line treatment in combination with pemetrexed for treating patients with advanced NSCLC.[126] In these patients, the electrodes are placed on the skin over the tumor site.

Clinical Pathway at Point of This Intervention

After their disease is diagnosed as glioblastoma, patients typically undergo debulking surgery to remove as much of the tumor as possible. At that time, some patients may undergo implantation with a carmustine (BCNU)-impregnated wafer.[127] Depending on the patient's physical condition, adjuvant radiation therapy, chemotherapy (typically temozolomide), or a combination of the two are sometimes given. After adjuvant therapy, some patients may undergo maintenance therapy with temozolomide. In patients with disease that recurs after these initial therapies, additional debulking surgery may be used if recurrence is localized. Systemic therapy options for recurrent disease include bevacizumab, bevacizumab plus chemotherapy (e.g., irinotecan, BCNU/CCNU, temozolomide), temozolomide, nitrosourea, PCV (procarbazine, CCNU, and vincristine), cyclophosphamide, and platinum-based agents.[127] The April 2011 FDA approval of the NovoTTF-100A system provides another treatment option in the recurrent disease setting.[118]

Figure 7. Overall High Impact Potential: Tumor-treating fields therapy (NovoTTF-100A) for glioblastoma multiforme



Although experts commenting on this intervention were generally enthusiastic about the idea of a noninvasive therapy with a novel mechanism of action for this type of cancer that appeared to offer fewer side effects, experts cautioned that the data suggested the therapy exhibits marginal, if any, survival benefit over available therapies. They speculated that patients and clinicians might be unlikely to adopt an unorthodox therapy administered at home around the clock without more data demonstrating its efficacy, unless it is the only treatment option left for a patient. Based on this input, our overall assessment is that this intervention is in the lower end of the high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, health systems, and health administration backgrounds, provided perspectives on the use of TTF for treating glioblastoma multiforme.[128-134] While experts agreed that a significant unmet need exists for novel treatments for patients with recurrent glioblastoma multiforme because of their poor prognosis and quality of life with current treatments, experts were less certain that TTF therapy could meet that unmet need. Experts believe that the underlying scientific theory behind TTF therapy seemed plausible, but noted that current data suggest that the therapy has only marginal survival benefits, if any. One clinical expert noted that the therapies used in the active comparator arm of the clinical trial in the recurrent disease setting had previously demonstrated little to no efficacy and suggested that data from the ongoing trial of TTF versus placebo as an adjunct to standard chemotherapy might provide a better assessment of

treatment efficacy. One expert with a clinical background noted that a therapy such as TTF that has minimal side effects relative to conventional chemotherapy could significantly improve patient quality of life; however, an expert with a research background suggested that further data demonstrating that the therapy does not exert adverse effects on normal tissue are needed. While experts had some doubts about the efficacy of TTF, an expert with a research background noted that demonstration of the efficacy of alternating electrical fields in the inhibition of tumor growth could represent a significant shift in our understanding of the disease and its potential treatments.

However, even if the therapy is proven to be efficacious, experts believe, some significant barriers exist for clinician and patient adoption. Multiple experts noted that clinicians and patients alike could be reluctant to adopt the use of such a novel, unorthodox technology. Conversely, one expert with a clinical background suggested that patients would be willing to try a treatment that promises to reduce side effect profiles relative to another round of chemotherapy. Lastly, multiple experts noted that at-home treatment would require significant effort on the patient's part to adhere to treatment recommendations, citing the need to continuously shave electrode-attachment sites and maintain device operability for 20–24 hours per day.

Hematologic Malignancy Interventions

Brentuximab Vedotin (Adcetris) for Recurrent or Treatment-Refractory Hodgkin's Lymphoma or Anaplastic, Large Cell Lymphoma

CD30 is a defining marker of Hodgkin's lymphoma (HL) and anaplastic, large cell lymphoma (ALCL).[135] Both HL and ALCL are rare, with about 8,500 cases of HL and 2,250 cases of ALCL diagnosed annually in the United States.[136,137] While many patients achieve complete remission following standard treatments for HL and ALCL, a significant proportion has disease that is refractory to standard therapies or recurs after first-line treatment. Available treatments for recurrent or refractory HL and ALCL provide little benefit to affected patients, and no consensus exists on optimal treatment of these patients.[137]

Brentuximab vedotin (Adcetris®) is an antibody-drug conjugate (ADC) targeted to CD30 that has been developed for treating patients with recurrent or refractory HL or ALCL.[135,137] The biologic compound consists of a CD30-specific monoclonal antibody chemically conjugated to a potent, chemotherapeutic agent, monomethyl auristatin E (MMAE).[138] Brentuximab vedotin is intended to target CD30-expressing cells and contains a novel peptide-based linking system designed to allow it to remain stable in the bloodstream and only release the cytotoxic MMAE upon ADC internalization by CD30-positive cells.[139] By targeting the cytotoxic molecule to CD30-expressing tumor cells, brentuximab vedotin is purported to minimize systemic toxicity while focusing cytotoxic effects on the target tumor.

Seattle Genetics, Inc. (Bothell, WA), in collaboration with the Millennium Pharmaceuticals subsidiary of Takeda Pharmaceutical Co., Ltd. (Osaka, Japan), developed the agent. Treatment consists of an intravenous infusion of 1.8 mg/kg of body weight every 3 weeks for up to 16 total doses.[140] Common adverse effects reported in trials included diarrhea, fatigue, nausea, neutropenia, peripheral neuropathy, and pyrexia, which were characterized as "manageable."[141,142] Since the time of these trials, three cases of progressive multifocal leukoencephalopathy, a brain infection that can result in death, have been reported in patients who were undergoing brentuximab vedotin treatment.[143]

Researchers have reported results from two open-label, single-group assignment, phase II clinical trials; one trial in patients with relapsed or refractory HL and one trial in patients with relapsed or refractory ALCL. In the trial of patients with relapsed or treatment-refractory HL (n=102), the overall response rate as assessed by an independent review facility was 75%, and 34% of patients achieved complete remission.[139] The median response duration was 5.6 months as assessed by independent central review, and among patients achieving a complete remission, the median response duration was reported to be 20.5 months.[139] In the clinical trial of the agent in patients with relapsed or treatment-refractory ALCL (n=58), the overall response rate as assessed by an independent review facility was 86%, and 53% of patients achieved complete remission.[144] The median response duration had not been reached when results were given and ranged from 0.3 to 45.3 weeks.[144]

Seattle Genetics has commercialization rights in the United States and Canada. After granting the agent orphan drug designation in 2007 and fast track status in 2009, FDA approved it in August 2011 for treating both HL and ALCL.[145] The approved indications are for patients with HL who have failed to respond to an autologous stem cell transplantation or whose disease has progressed after at least two multiagent chemotherapy regimens and who are not autologous stem cell transplant candidates and for patients with ALCL after failure of at least one multiagent chemotherapy regimen.[145,146] Besides the FDA-approved indications in relapsed or refractory

disease, early-phase, clinical trials incorporating brentuximab vedotin into first-line chemotherapy regimens for treating HL and ALCL are ongoing.[147,148]

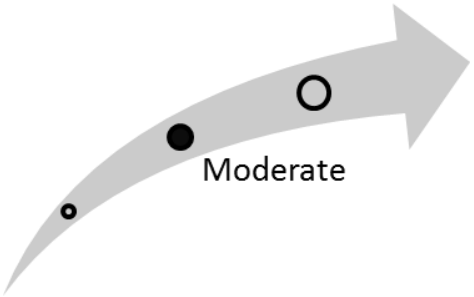
The initial drug pricing was set at about $4,500 per vial with about three vials used per treatment and 7–9 cycles of treatment given per patient, bringing the total cost for a complete regimen to a range of $94,000 to $121,000.[149,150] Among 11 major, private, third-party payers that publish their policies online (i.e., Aetna, Anthem, Blue Cross/Blue Shield Alabama, Blue Cross/Blue Shield Massachusetts, CIGNA, HealthPartners, Humana, Medica, Regence, Wellmark, United Healthcare), all identified policies (at 6 payers) covered the use of brentuximab vedotin in the FDA-approved indications.[151-156] Seattle Genetics has a patient assistance program that may provide assistance to both uninsured and underinsured patients as well as assistance with coinsurance payments.[157]

Clinical Pathway at Point of This Intervention

Standard treatment for HL consists of chemotherapy, involved-field radiation therapy, extended-field radiation therapy, and combined modality treatment; common chemotherapies used in combined modality treatment include AVBD (adriamycin [doxorubicin], vinblastine, bleomycin, and dacarbazine) and Stanford V (mechlorethamine, doxorubicin, vinblastine, vincristine, bleomycin, and prednisone).[136] Patients whose disease progresses following first-line therapy may undergo subsequent treatment(s) with radiation therapy, high-dose chemotherapy coupled with autologous stem cell transplantation, or one of a range of salvage chemotherapy regimens.[136]

Patients in whom ALCL has been diagnosed typically undergo first-line therapy with an anthracycline-based chemotherapy combination, most commonly CHOP (cyclophosphamide, doxorubicin, vincristine, prednisone).[158] Some patients, in particular patients with anaplastic lymphoma kinase (ALK)-negative disease, may undergo consolidation chemotherapy consisting of a high-dose chemotherapy regimen with stem cell rescue.[158] No consensus treatment has been established in patients who do not respond to first-line therapy or have recurrent disease following first-line treatment; however, patients are typically treated with a new chemotherapy regimen, including EPOCH (etoposide, prednisone, vincristine, cyclophosphamide, doxorubicin), ESHAP (etoposide, methylprednisone, cytarabine, cisplatin), or ICE (ifosfamide, carboplatin, etoposide).[137,158]

Figure 8. Overall High Impact Potential: Brentuximab vedotin (Adcetris) for recurrent or treatment-refractory Hodgkin's lymphoma or anaplastic large cell lymphoma



Overall, experts commenting on this intervention believe that the potential impact of brentuximab vedotin is high as a novel ADC that may have the potential to effectively treat CD30-positive malignancies that are refractory to standard therapies and have few treatment options. However, the overall impact on the health care system would be limited by the routine manner of administration and the relatively small patient population affected by these conditions. Based on this input, our overall assessment is that this intervention is in the moderate high-potential-impact range.

Results and Discussion of Comments

Six experts, with clinical, research, and health systems backgrounds, offered comments on use of brentuximab vedotin.[159-164] Overall, experts concurred that the lack of efficacious treatments for these cancers represents an important unmet need for new treatment options. All but one expert thought that the available data suggested that brentuximab vedotin has significant potential to improve health outcomes of HL patients, citing the high response rate observed in the clinical trial and the fact that no other therapy had shown a significant benefit in this patient population. However, several experts noted that the completed trials were single-arm clinical trials that only reported a response rate and, therefore, a clear survival benefit had not yet been demonstrated.

Despite the preliminary nature of the data, the majority experts thought that brentuximab vedotin would be widely accepted by both patients and clinicians because of the lack of effective treatment options for patients with HL and the high response rate reported in trials. Multiple experts also cited the brentuximab vedotin's relatively benign adverse event profile as another factor influencing physician and patient adoption; however, a few experts suggested that the reports of high rates of peripheral neuropathy and rare cases of progressive multifocal leukoencephalopathy could discourage physicians and patients from opting for the treatments.

All experts agreed that brentuximab vedotin would increase the cost of care because it would be additive to the current clinical pathway for HL. Multiple experts suggested that the high cost of brentuximab vedotin could potentially make the drug inaccessible to underserved patients, possibly worsening existing health disparities. While all experts indicated that they believed brentuximab vedotin would lead to increased costs, multiple experts suggested that further studies could lead to the use of brentuximab vedotin earlier in the treatment pathway and, if this adoption improved long-term response rates, it could limit downstream costs associated with expensive second-line therapies such as autologous stem cell transplantation.

Six experts, with clinical, research, and health systems backgrounds, offered comments on the use of brentuximab vedotin for treating ALCL.[165-170] Experts were unanimous in their opinion that patients with ALCL whose cancer failed to be cured by first-line chemotherapy (and in some cases, stem cell transplantation) have few effective treatment options and poor prognosis; therefore, this disease setting represents a significant unmet need. However, the majority of experts also noted that ALCL is a rare condition, which would limit potential impact of this therapy on the overall health system.

The majority of experts believe that the high response rates demonstrated in the phase II trial in patients with treatment-refractory ALCL suggests that brentuximab vedotin has significant potential to improve patient health outcomes. However, multiple experts noted that longer term, followup data are needed to determine whether these responses are durable. Additionally, several experts suggested that the lack of a control arm in the trial made it difficult to assess the response rates. With those data limitations in mind, one expert with a research background suggested that brentuximab vedotin has only minimal potential to improve patient health outcomes, compared with salvage therapy options.

Experts did not think that an intravenously administered chemotherapy drug that would be used in a patient population that has likely already undergone prior rounds of intravenous therapy would necessitate significant changes in health care facility staffing or infrastructure or the manner in which patients with ALCL are managed. However, one expert with a clinical background suggested that brentuximab vedotin could alter the continuum of care for ALCL if it is shown to be safe and effective in first-line disease treatment.

Experts were unanimous in their opinion that both physicians and patients would be highly likely to adopt the use of brentuximab vedotin for treating ALCL, citing the lack of alternatives

demonstrating efficacy in refractory ALCL and the encouraging response rates reported in the clinical trial. Additional factors noted by experts as influencing adoption included the routine and familiar route of administration and the relatively benign side-effect profile. Like experts commenting on the use of brentuximab vedotin for treating HL, experts suggested that reports of high rates of peripheral neuropathy and sporadic reports of progressive multifocal leukoencephalopathy could discourage some patients from opting for brentuximab vedotin treatment.

While all experts noted the high cost of brentuximab vedotin treatment per patient, many suggested that the impact on overall health care system costs would be limited by the small number of patients with ALCL who would receive the treatment.

JAK 1/2 Inhibitor (Ruxolitinib, Jakafi) for Treatment of Myelofibrosis

Myelofibrosis is one of three closely related disorders (myelofibrosis, polycythemia vera, essential thrombocytosis) caused by abnormalities in the myeloid hematopoietic lineage that lead to clonal expansion of a myeloid progenitor cell. One of the primary symptoms of myelofibrosis is splenomegaly (i.e., enlarged spleen) caused by abnormal myeloid cells accumulating in the spleen.[171] Current treatments for myelofibrosis are largely palliative, and novel treatments are needed.

One molecular target that may be amenable to pharmaceutical intervention for treating myelofibrosis is the JAK/STAT pathway. JAK/STAT activity has been implicated in the clonal proliferation of myeloid progenitor cells that leads to myelofibrosis. In particular, genetic mutations that lead to JAK/STAT pathway activation (e.g., activating mutations in JAK2, a tyrosine kinase that functions in the JAK/STAT pathway) have been identified in approximately two-thirds of myelofibrosis cases.[172,173] Besides a potential role in driving clonal proliferation, JAK/STAT signaling may also play a role in the elevated levels of proinflammatory cytokines observed in myelofibrosis and that likely contribute to disease symptoms.[174] JAK/STAT signaling is known to be involved in both producing proinflammatory cytokines and mediating the effects of cytokines in target cells; therefore, inhibition of JAK kinases also has the potential to improve myelofibrosis symptoms by limiting inflammation.[174]

Ruxolitinib is a small-molecule, kinase inhibitor that has activity against both JAK1 and JAK2 tyrosine kinases and represents the first JAK/STAT pathway inhibitor for treating myelofibrosis.[175] Ruxolitinib was developed by Incyte Corp. (Wilmington, DE) in cooperation with Novartis International AG (Basel, Switzerland), which holds rights to the compound outside the United States.[176]

Ruxolitinib has been studied in two phase III clinical trials (COMFORT-I and COMFORT-II). In COMFORT-I, the safety and efficacy of treating patients with myelofibrosis using ruxolitinib (n=155) was compared with placebo (n=154).[177] In results published in 2012, investigators reported that 41.9% of patients in the ruxolitinib arm achieved a 35% or greater reduction in spleen size at 24 weeks compared with 0.7% of patients in the placebo arm ($p < 0.001$).[177] In COMFORT-II, the safety and efficacy of treating patients in whom myelofibrosis had been diagnosed with ruxolitinib (n=146) was compared with best alternative therapy consisting of another agent or no treatment (n=73).[178] In results published in 2012, researchers reported 28% of patients in the ruxolitinib arm exhibited a 35% or greater reduction in spleen size at 48 weeks versus 0% of patients in the best alternative therapy arm ($p < 0.001$).[178]

Adverse events were reported as more common in the ruxolitinib arms of the two trials compared with the placebo or best alternative therapy arms.[177,178] The most common adverse events included anemia, diarrhea, peripheral edema, and thrombocytopenia. Grade 3 or 4 adverse events were observed in less than 10% of patients treated with ruxolitinib and included anemia and thrombocytopenia, which may require blood transfusions.[179] Besides adverse events observed during treatment, instances of serious adverse events (e.g., acute relapse of symptoms, rapid and painful spleen enlargement, acute hemodynamic decompensation) have been reported following discontinuation of ruxolitinib treatment.[174]

In November 2011, FDA approved ruxolitinib for treating intermediate- or high-risk myelofibrosis (including primary myelofibrosis, post-polycythemia vera myelofibrosis and post-essential thrombocythemia myelofibrosis).[179,180] Incyte has set the retail price of ruxolitinib at

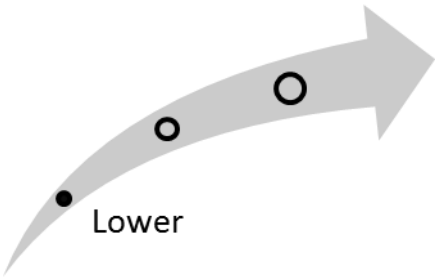
$7,000 for 1 month of treatment.[181] The drug is listed as a specialty pharmaceutical with most third-party payers and requires prior authorization.

Ruxolitinib is also under study in a phase III trial for treating polycythemia vera as well as earlier-phase trials for other hematologic malignancies.[182]

Clinical Pathway at Point of This Intervention

Following diagnosis of a myelofibrosis disorder, symptomatic patients may undergo palliative treatments such as blood transfusions or androgen therapy for anemia, hydroxyurea chemotherapy, radiation therapy, combination thalidomide and prednisone treatment, or splenectomy.[183] Patients may also undergo allogeneic stem cell transplantation to attempt to cure the condition.[183] Ruxolitinib represents an additional treatment option for patients with myelofibrosis.

Figure 9. Overall High Impact Potential: JAK 1/2 inhibitor (ruxolitinib, Jakafi) for treatment of myelofibrosis



Overall, experts believe that ruxolitinib addresses a significant unmet need for novel treatments for myelofibrosis and that the mechanism of action of ruxolitinib was highly suited to this indication. While experts believe that it would likely be adopted by physicians and patients based on encouraging data regarding spleen size, experts were cautious, given the lack of data on patient survival and disease progression. Lastly, experts did not envision an oral medication intended for use in a relatively small patient population as having significant impacts on the health care system. Based on this input, our overall assessment is that this intervention is in the lower end of the high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, health systems, and health administration backgrounds, offered perspectives on this topic.[184-190] Experts concurred that a significant unmet need exists in the treatment of myelofibrosis, citing the lack of FDA-approved therapies for this condition and the inadequacy of current treatments. Experts also believe that the purported mechanism of action of ruxolitinib, in particular its activity against JAK2, was a highly logical approach to treating this condition. While experts were positive about the available data on ruxolitinib's effectiveness, multiple experts noted that ruxolitinib had only demonstrated an effect on spleen size and that its long-term effects on patient survival and disease progression were unknown. Still, given the lack of effective myelofibrosis treatment options, the majority of experts believe that ruxolitinib would displace current therapies for many patients in whom myelofibrosis has been diagnosed.

As an oral medication that would be used to treat a relatively rare disease, ruxolitinib was not expected by the experts to have a significant impact on health care staffing or infrastructure. Similarly, the majority of experts did not envision an oral medication such as ruxolitinib causing significant shifts in health care processes or health care setting.

The majority of experts agreed that patients and physicians alike would be likely to adopt ruxolitinib, citing the lack of effective alternative therapies and the ease and convenience of prescribing and taking an oral medication. Multiple experts with clinical backgrounds cautioned that it may not initially be clear whether ruxolitinib would be indicated for all patients, which may slow physician adoption. One clinical expert also noted that ruxolitinib would likely be a highly expensive drug, which, depending on insurance coverage and reimbursement policies, may restrict patient use. A second clinical expert noted that up to 10% of patients experienced severe adverse reactions during ruxolitinib treatment, which might dissuade some patients from opting for the treatment, especially if no impact on survival or disease progression is observed. Citing the lack of data on ruxolitinib's effect on survival, multiple experts suggested that the cost-benefit ratio for this therapy has the potential to generate some controversy if it is seen as only a palliative therapy.

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Lung Cancer Intervention

Crizotinib (Xalkori) for Treatment of Nonsmall Cell Lung Cancer

Current chemotherapy options for patients with advanced nonsmall cell lung cancer (NSCLC) have a relatively low response rate to current therapies (25% to 30%) and result in 2-year survival rates of only 10% to 15%[191]; therefore, the need is significant for new treatments for this condition. In recent years it has been shown that NSCLC is not a single disease, but rather a collection of related diseases with different molecular underpinnings. In particular, it has been shown that 2% to 7% of NSCLC tumors harbor genetic alterations that result in a fusion of the *ALK* gene with a second gene (e.g., *EML4*).[192] The *ALK* gene encodes a receptor tyrosine kinase that regulates multiple cellular processes, and gene fusions can result in production of an ALK protein product that is constitutively active, which can drive carcinogenesis.[192] Targeted inhibition of ALK kinase activity is a promising therapeutic alternative for these individuals.

Crizotinib (Xalkori®, Pfizer, Inc., New York, NY) is an oral chemotherapy drug that functions as an inhibitor of both ALK and hepatocyte growth factor receptor tyrosine kinase (MET).[193] Early clinical trials of crizotinib demonstrated a tumor response in a subset of patients whose tumors harbored an activating *ALK* mutation, and subsequent studies of crizotinib have focused on tumors containing similar *ALK* mutations. A genetic test on a tumor sample is required to identify patients who may benefit from crizotinib therapy.[192]

In a single-arm, phase II study published in 2010, Kwak and colleagues reported on 82 patients with *ALK*-mutation positive NSCLC who were treated using crizotinib monotherapy.[192] They reported that 57% of patients in the trial had a tumor response based on Response Evaluation Criteria in Solid Tumors criteria (46 partial responses and 1 complete response), and 33% of patients exhibited stable disease after a median treatment duration of 6.4 months. The twice-daily dose of 250 mg used in the trial was generally well tolerated; frequently reported adverse effects included grade 1 or 2 gastrointestinal side effects. Two phase III trials of crizotinib in the first- and second-line treatment setting are under way.[194,195]

In 2011, FDA approved the drug on the basis of two single-arm trials involving 136 and 119 patients with *ALK* mutation-positive NSCLC, in whom crizotinib treatment generated an overall objective response rate of 50% and 61%, respectively.[196] The approval was for patients with locally advanced or metastatic NSCLC that is *ALK*-positive as detected by the FDA-approved test, Vysis ALK Break Apart FISH Probe Kit.[197]

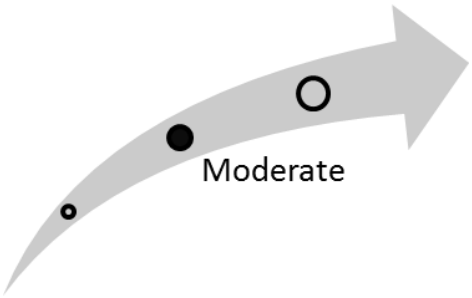
The drug cost is about $115,000 per patient per year ($9,600 per month).[198] The list price of the companion diagnostic test is approximately $225 per test, but the full cost of the test will also include a fee for performing the test.[199] Among 11 major, private, third-party payers that publish their policies online (i.e., Aetna, Anthem, Blue Cross/Blue Shield Alabama, Blue Cross/Blue Shield Massachusetts, CIGNA, HealthPartners, Humana, Medica, Regence, Wellmark, United Healthcare), all 9 identified policies indicated that the payer covered the use of crizotinib for the FDA-approved indication in NSCLC.[200-208] Pfizer introduced a plan to help reduce patient out-of-pocket costs for copays for some patients to $100 per prescription for an annual maximum savings of $24,000.[198]

Clinical Pathway at Point of This Intervention

The initial treatment of NSCLC typically involves surgery to remove the diseased portion of the lung. However, if the tumor is large and/or has spread to adjacent lymph nodes, neoadjuvant chemotherapy and radiation therapy is sometimes used before surgery to reduce the size of the tumor. Following surgery, patients may undergo sequential radiation therapy and chemotherapy or combined chemoradiation treatment. Multiple first- and second-line chemotherapy agents are

available for treating lung cancer.[209] The choice of one chemotherapy option over the others depends in part on the characteristics of the tumor (e.g., tumor histology, presence of specific genetic changes).[209] Crizotinib represents another first- or second-line chemotherapy option for patients with cancers bearing a specific genetic change at the ALK locus.[210]

Figure 10. Overall High Impact Potential: Crizotinib (Xalkori) for treatment of nonsmall cell lung cancer



Overall, experts commenting on this intervention thought that it would be readily adopted by physicians and patients and has potential to significantly improve health outcomes for the small (*ALK*-positive) metastatic NSCLC patient population targeted by this drug. Use of the drug requires a test for eligibility, which experts indicated would change the care pathway and add to costs. Its use could also change the care setting because it might supplant infused chemotherapy options with an at-home oral medication. However, experts thought that the limited number of patients who would be eligible for this treatment might limit its overall impact on all patients with NSCLC. Based on this input, our overall assessment is that this intervention is in the moderate high-potential-impact range.

Results and Discussion of Comments

Eight experts, with clinical, research, health systems, and health administration backgrounds, offered perspectives on this intervention.[211-218] All experts agreed that a significant unmet need existed for novel therapies for NSCLC, citing the short duration of survival for patients with advanced NSCLC when treated with available therapies. However, several experts noted that the significance of the unmet need purported to be addressed by crizotinib is limited by the fact that the treatment is targeted to only a small subset of patients with NSCLC that harbors an *ALK* mutation. For this select patient population; however, the majority of experts indicated that the available data suggested that crizotinib has significant potential to improve patient health, citing the high response rate and an indication that crizotinib may improve patient survival. One expert with a clinical perspective suggested that drugs like crizotinib that are intended for a select, targeted patient population with a high rate of response to the therapy should serve as a paradigm for future cancer-drug development. Several experts noted that a clearer picture of the benefits of crizotinib would be generated after the completion of ongoing randomized controlled trials comparing crizotinib to standard treatment options.

The majority of experts did not envision that crizotinib would require significant shifts in patient management. While multiple experts noted that identifying the small number of patients eligible for crizotinib would require screening a large number of patients with NSCLC, some experts noted that this may not represent a major shift given that molecular testing (e.g., EGFR mutation status) is already routinely performed on biopsy samples from NSCLC patients. Two experts with clinical perspectives suggested that some patients might have to undergo multiple biopsies if insufficient

tumor tissue was recovered to perform all necessary molecular diagnostic tests. Besides the additional testing requirements, another reviewer with a clinical perspective suggested that the shift from intravenous chemotherapy agents to an orally administered agent such a crizotinib would require a shift in the way in which patients are observed for adverse effects of the therapy.

All experts thought that crizotinib would be readily adopted by physicians and patients alike, citing the few viable alternatives, the drug's activity, and the drug's relatively well-tolerated safety profile. Additionally, multiple experts suggested that patients would prefer to take an orally administered medication at home rather than traveling to infusion centers for treatment. However, multiple experts noted the potential for patients to be burdened with a large copayment for crizotinib, which could limit adoption by some patients and could potentially worsen health disparities for certain underserved patient populations.

Prostate Cancer Interventions

Abiraterone (Zytiga) for Treatment of Metastatic Castration-Resistant Prostate Cancer

Men with metastatic castration-resistant prostate cancer (mCRPC; i.e., cancer that is insensitive to androgen withdrawal) have few treatment options and a poor prognosis. Recently reported survival time for this patient population given available therapies is approximately 22 months.[219] Novel treatments for this stage of prostate cancer are highly desired, especially for patients whose disease has progressed after first-line treatment with docetaxel.

mCRPC can progress in presence of castration-level androgens and, therefore, appears to be independent of androgen signaling, which is the primary driver of prostate tumor growth. However, recent research has suggested that these cancers may still depend on androgen receptor signaling, which may be activated by residual androgens produced in the prostate tissue or adrenal glands of patients who have been surgically or medically castrated.[219] Therefore, further inhibition of androgen signaling may have activity as an mCRPC treatment. One compound intended to function by reducing levels of residual androgens is abiraterone (Zytiga®, Centocor Ortho Biotech, Inc., which has been acquired by Janssen Biotech, Inc., a unit of Johnson & Johnson, New Brunswick, NJ). Abiraterone is an orally administered pregnenolone analog that acts as an inhibitor of the enzyme CYP17, an enzyme involved in a rate-limiting step of androgen biosynthesis.[219] Abiraterone has been under study for treating both patients with symptomatic mCRPC that has progressed after treatment with docetaxel (NCT00638690) and patients with asymptomatic or mildly symptomatic mCRPC that is systemic-chemotherapy naïve (NCT00887198).

FDA approved abiraterone in April 2011 in combination with prednisone for treating mCRPC that had previously been treated with docetaxel.[220] This approval was based on results from a phase III, randomized, placebo-controlled trial that showed that overall survival in the abiraterone plus prednisone arm was 15.8 months versus 11.2 months in the placebo plus prednisone arm (hazard ratio[HR], 0.74).[220] Researchers reported that common adverse events associated with abiraterone treatment were hypertension, hypokalemia, and edema, which they reported to be manageable through treatment.[219] A supplemental new drug application for use of abiraterone in patients who are chemotherapy-naïve was expected to be filed in the second half of 2012 following the March 2012 announcement that a trial of patients in this setting had been unblinded after the Data and Safety Monitoring Board determined that abiraterone plus prednisone demonstrated improved efficacy relative to placebo plus prednisone.[221]

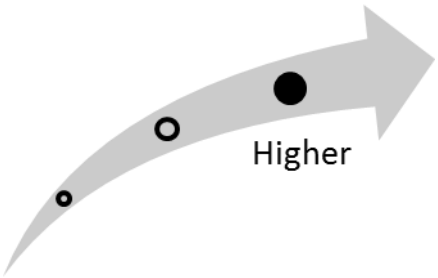
Abiraterone's cost has been reported as about $5,000 per month of treatment.[222] A query of an online pharmacy in January 2012 identified a retail price of $6,840 for a 30-day abiraterone supply.[52] A survey of 11 major, private, third-party payers that publish their policies online (i.e., Aetna, Anthem, Blue Cross/Blue Shield Alabama, Blue Cross/Blue Shield Massachusetts, CIGNA, HealthPartners, Humana, Medica, Regence, Wellmark, United Healthcare) indicated that third-party payers generally reimburse for abiraterone for the FDA-approved indication (i.e., post-docetaxel chemotherapy and in combination with prednisone).[223-233] The majority of these third-party payers require prior authorization for coverage.

Additional compounds that target androgen signaling in mCRPC are in development, including a second CYP17 inhibitor (Orteronel [TAK-700]) and a novel androgen receptor signaling inhibitor (MDV3100).[234,235] Both compounds are in phase III clinical trials for both chemotherapy-naïve and postchemotherapy mCRPC. MDV3100's developer recently reported preliminary results from a 1,199-patient, phase III trial in the postdocetaxel setting. Compared with patients treated with placebo, patients treated with MDV3100 were reported as exhibiting a 4.8-month increase in duration of overall survival (18.4 months vs. 13.6 months [HR, 0.631]).[236]

Clinical Pathway at Point of This Intervention

Traditionally, androgen deprivation therapy either by bilateral orchiectomy (surgical castration) or luteinizing hormone-releasing hormone agonist (medical castration) has been used to treat advanced prostate cancer when surgery and/or radiation are not indicated.[237] Yet, few options are available for patients whose cancer becomes resistant to androgen deprivation and progresses to mCRPC. mCRPC that is not symptomatic or only mildly symptomatic may be treated with the autologous cancer vaccine sipuleucel-T (Provenge®).[237] For patients with more advanced, symptomatic mCRPC, the standard first-line treatment is systemic chemotherapy with the taxane docetaxel.[237] Lastly, for patients whose disease progresses after treatment with docetaxel, treatment with the recently approved taxane cabazitaxel in combination with prednisone may be used.[237] Abiraterone represents a potential treatment alternative to cabazitaxel in the postdocetaxel setting and could be used as an alternative to or in sequence with the immunotherapy sipuleucel-T in the predocetaxel/chemotherapy setting.

Figure 11. Overall High Impact Potential: Abiraterone (Zytiga) for treatment of metastatic castration-resistant prostate cancer



Overall, experts commenting on this intervention were quite positive regarding abiraterone's potential to improve both quality and quantity of life for patients diagnosed with mCRPC; however, some experts pointed out that the demonstrated improvement in survival duration is marginal (a few months) in patients whose disease has not responded to first-line chemotherapy. They noted that results from a study of patients with earlier stages of mCRPC are highly anticipated. These results were expected to be released in June 2012. Based on this input, our overall assessment is that this intervention is in the moderate range of the high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, health systems, and health administration backgrounds, offered perspectives on this intervention.[238-244] Experts uniformly indicated a high unmet need for effective treatments for mCRPC, a need that abiraterone purports to address. The need is high because few treatment options are available to these patients, and survival rates are low and of short duration. In particular, one clinical expert pointed to a significant need for therapies such as abiraterone in asymptomatic mCRPC for which current treatments are difficult to administer and/or expensive. Similarly, the experts also concurred that the scientific rationale behind limiting residual androgen production in mCRPC seems to be valid. One clinical expert suggested that the success of interfering with androgen signaling in mCRPC could lead to a shift in the understanding of disease progression.

Experts commented that they did not expect abiraterone to cause a significant change to prostate cancer care; rather, it would be used in place of or after current therapies. One clinical expert noted that the androgen receptor antagonist, ketoconazole, though never approved for a prostate cancer indication, has been used in a similar manner to that proposed for abiraterone. Additionally, experts

did not believe that abiraterone would cause a significant shift in care setting, health care staffing, or health care facility infrastructure requirements because of its nature as an orally administered medication. They believe it would increase costs of care by adding an option after other options had been exhausted. The estimated cost of treatment is about $60,000 per patient per year, which some experts thought was not a tremendous increase compared with sipuleucel-T's cost of $93,000 per year and cabazitaxel, which costs more than abiraterone but not as much as Sipuleucel-T.

While several experts noted that treatment with abiraterone resulted in only a modest increase in survival, experts agreed that it would likely be adopted by patients and physicians because of its ease of use and low side-effect profile relative to chemotherapy. One clinical expert noted that the potential for adverse events associated with adrenal androgen production may dissuade some physicians and patients from use.

Radium-223 (Alpharadin) for Treatment of Solid Tumor Bone Metastases

Many cancers, in particular cancers of the breast, prostate, and lung, metastasize to bone, where they can cause complications such as chronic pain and skeletal-related events (e.g., fractures) that can adversely affect both patient quality of life and survival.[245] Current treatments targeting bone metastases are largely palliative in nature, providing relief from pain or delaying skeletal-related events without having significant effects on overall disease progression or patient survival. Alpharadin® has the potential to be the first bone metastasis-targeted agent that has effects on both bone metastasis symptoms and patient survival.

Among the current treatment options for bone metastases are the radionuclides strontium-89 and samarium-153-EDTMP (ethylenediamine tetra [methylene phosphonic acid]), radioactive molecules that have a natural affinity for sites of bone remodeling, which occurs at bone metastases.[245] Preferential accumulation of the radioactive compound purportedly concentrates the radiation dose at the target bone metastases. While available radionuclides have shown efficacy in the palliation of bone pain, the type of radiation that they emit penetrates tissues deeply enough to negatively impact the bone marrow, which limits the deliverable dose and restricts their use to one of symptom palliation.[246] Alpharadin (a preparation of radium-223) is a novel bone metastasis-targeting radiopharmaceutical that emits alpha particles, which have higher energies and more localized activity than the radiation generated by available radiopharmaceuticals.[247] This may both reduce the side effects of treatment relative to current radionuclide treatments and improve patient outcomes.[247]

The developers of Alpharadin (Algeta ASA, Oslo, Norway, and Bayer AG, Leverkusen, Germany) recently announced preliminary results from a randomized, double-blind, clinical trial of Alpharadin versus placebo in treating 900 patients with castration-resistant prostate cancer (CRPC) with skeletal metastases who were ineligible for initial treatment or further treatment with docetaxel.[248] An independent committee recommended that the trial be stopped following an interim analysis that demonstrated treatment with Alpharadin improved overall survival relative to placebo (median overall survival 14.0 vs. 11.2 months; two-sided p-value=0.0022; HR, 0.699).[248] Treatment with Alpharadin was also reported to have demonstrated improvement in secondary endpoints such as the time to first skeletal-related event, percentage of patients achieving normalized total alkaline phosphatase levels, and time to prostate-specific antigen progression.[248] Commonly reported adverse events included anemia, bone pain, constipation, diarrhea, nausea, and vomiting; however, rates of adverse events were similar in the Alpharadin and placebo arms of the trial.[248] The relatively benign adverse-event profile of Alpharadin treatment may allow its use in combination with existing cancer treatments. An early-phase, clinical trial is under way testing the combination of Alpharadin with the standard chemotherapy agent docetaxel in treating of CRPC.[249]

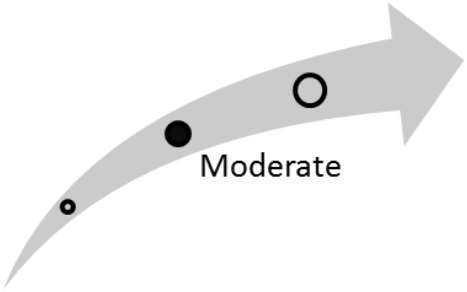
FDA has granted Alpharadin fast track status for treating CRPC with bone metastases.[250] A new drug application for this indication was anticipated to be filed some time in 2012.[245] Alpharadin is also under study for treating patients who have breast cancer with skeletal metastases; however, these trials are only at the phase II stage.[245]

An additional developmental agent that has exhibited promise in treating prostate cancer bone metastases is the MET/RET/VEFGR2 kinase inhibitor cabozantinib; phase III clinical trials of this compound in treating prostate cancer have been initiated.[251]

Clinical Pathway at Point of This Intervention

Patients with systemic cancer that has metastasized to bone are typically treated with a combination of locoregional treatment of bone metastases, systemic therapies, and pain medications.[252] Palliative local treatments for bone metastases include external beam radiation therapy and surgical resection of the lesion.[245] Systemic treatments include antineoplastic therapies such as chemotherapy and hormone therapy as well as agents that modulate bone remodeling such as bisphosphonates and the RANKL antibody denosumab.[245] Additional systemic agents that are targeted to bone include radiopharmaceuticals such as strontium-89 and samarium-153-EDTMP, which preferentially accumulate in sites of bone metastasis and expose the cancer cells to beta and/or gamma radiation.[252] Radium-223 would represent a novel systemic radionuclide treatment for bone metastases that would be the first alpha-particle-emitting radionuclide indicated for treating this condition.

Figure 12. Overall High Impact Potential: Radium-223 (Alpharadin) for treatment of solid tumor bone metastases



Overall, experts suggested that Alpharadin has significant potential to improve on current treatments for bone metastases, particularly for patients with prostate cancer bone metastases. While experts thought there is significant potential for Alpharadin to be widely adopted for treating bone metastases, the highly similar nature of Alpharadin to existing treatments suggested to experts that adoption of Alpharadin use would have limited impact on health care system infrastructure and practices. Based on this input, our overall assessment is that this intervention is in the moderate high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, and health systems backgrounds, offered perspectives on this intervention.[253-259] The majority of experts rated the need for improved treatments for bone metastases as being moderately important or very important, citing the high prevalence of bone metastases in many advanced cancers and the significant impact that these metastases can have on patient quality of life and survival. Experts rating the unmet need addressed by Alpharadin as very important suggested that the compound's purported improved safety profile relative to existing radiopharmaceutical treatments for bone metastases represents a significant improvement. However, one expert with a research perspective who rated the unmet need addressed by Alpharadin as minimal suggested that the compound represents only an incremental improvement on existing radiopharmaceuticals.

All experts suggested that Alpharadin has moderate to large potential to improve patient health, citing the increased duration of overall survival demonstrated in the recently completed phase III, clinical trial and the fact that the toxicity profile for Alpharadin appears to be relatively benign. Additionally, several experts noted the ability of Alpharadin to affect skeletal-related symptoms that

impact patient quality of life (e.g., pain) besides its effects on survival and disease progression. One expert with a clinical perspective expressed caution regarding the potential for long-sequelae of alpharadin treatment, noting that use of another radium isotope (radium-224) in treating ankylosing spondylitis had led to an increase in the incidence of leukemia in treated patients. However, the expert also noted that the two radium isotopes have differing decay patterns (which could alter the systemic radiation exposure) and that such long-term sequelae may not be as relevant to patient populations with poor long-term prognosis (e.g., patients with cancer that has metastasized to bone).

Generally, experts did not think Alpharadin would significantly shift health disparities. A few experts noted that the likely premium price of Alpharadin relative to existing palliative treatments might place the treatment out of reach for some patients, potentially worsening health disparities. Conversely, one expert with a clinical perspective suggested that underserved populations might present with more advanced disease and, therefore, Alpharadin might have a larger impact in these underserved populations.

Experts also did not think that Alpharadin would require significant changes to health care delivery and infrastructure or the manner in which patients are managed, noting the similarity between Alpharadin treatment methods and radiopharmaceuticals now used.

In line with their view that Alpharadin has significant potential to improve health outcomes, the majority of experts suggested that Alpharadin would likely be adopted by physicians and patients alike. Experts cited Alpharadin's reported efficacy in treating prostate cancer bone metastases, ease of use, and routine administration as factors influencing physician adoption and Alpharadin's relatively benign safety profile and potential to improve both severity of bone pain and duration of survival as factors influencing patient adoption. One expert with a research perspective suggested that some patients might be reluctant to opt for a treatment involving infusion of a radioactive isotope; however, this expert still believes that Alpharadin is likely to be widely adopted by patients.

Experts suggested that Alpharadin would likely be priced at a premium relative to current radiotherapy options and, therefore, the majority of experts indicated that Alpharadin would increase the overall cost of care. Multiple experts suggested that the potential high cost of this treatment could limit patient adoption if the price is out of reach for some patients.

Skin Cancer Interventions

B-RAF kinase Inhibitor (Vemurafenib, Zelboraf) for Treatment of Metastatic Melanoma

According to the American Academy of Dermatology, more than half of all new cases of melanoma in the United States in 2010 were invasive at the time of diagnosis.[260] Until recently, guidelines from the National Comprehensive Cancer Network indicated that no clearly optimal treatments for metastatic melanoma were available, and there was little consensus on standard therapy.[261] The recent approval of ipilimumab and vemurafenib for treating metastatic melanoma have provided the first treatments that generate a clear improvement in survival for this patient population.

Small-molecule inhibitors of the protein kinase B-RAF represent a recent addition to the metastatic melanoma treatment armamentarium.[262] B-RAF plays a central role in the RAS/MAP kinase signal transduction pathway, which regulates cell growth and cell proliferation. Misregulation of this pathway has been demonstrated to be involved in multiple cancers, and *B-RAF* gene mutations (e.g., *B-RAF*^{V600E}) encoding a constitutively active B-RAF protein have been identified in about 7% of cancers.[263] While only a small fraction of all human tumors harbor an activating *B-RAF* mutation, more than half of melanomas analyzed have been shown to bear such an allele.[263] Activated B-RAF is proposed to lead to hyperactivation of the downstream ERK/MEK/MAP kinase pathway, upon which melanomas may be dependent for growth and survival.[264] Therefore, the specific inhibition of B-RAF kinase activity is a promising pharmacologic target. Preclinical studies demonstrated that B-RAF inhibitors were able to inhibit signaling in the downstream MAP kinase pathway only in cells containing the activating *B-RAF*^{V600E} mutation.[263] Therefore, most studies have focused on patients whose cancers have been confirmed to contain this mutant form of *B-RAF*.

Vemurafenib (Zelboraf) is an orally administered, small-molecule inhibitor of B-RAF. Results were recently reported from the phase III BRIM3 study in which patients with metastatic melanoma (n=675) were randomly assigned to receive either vemurafenib or dacarbazine.[265] In this study, vemurafenib was reported to have met its two primary endpoints of increasing overall survival and increasing progression-free survival relative to treatment with dacarbazine.[265] Researchers reported that treatment with vemurafenib versus dacarbazine was associated with a 63% reduction in the chance of death and a 74% reduction in the chance of either death or disease progression ($p < 0.001$ for both analyses).[265] Commonly reported adverse events associated with vemurafenib treatment included alopecia, arthralgia, diarrhea, fatigue, keratoacanthoma or squamous-cell carcinoma, nausea, photosensitivity, and rash.[265] A companion diagnostic test (cobas 4800 *B-RAF V600* Mutation Test) that will allow determination of *B-RAF*^{V600} status was developed in tandem with vemurafenib.[266] In August 2011, FDA approved vemurafenib for treating patients with unresectable or metastatic melanoma with the *B-RAF*^{V600E} mutation as detected by an FDA-approved test.[267,268]

The reported cost of vemurafenib is about $9,400 per patient per month, and the company estimates a treatment course of about 6 months for a total of about $56,400 per patient.[269] Genentech offers a savings card to reduce out-of-pocket costs for patients with commercial health insurance, and the Genentech Access to Care Foundation may offer assistance to uninsured individuals who cannot afford their prescriptions.[270,271] Among 11 major, private, third-party payers that publish their policies online (i.e., Aetna, Anthem, Blue Cross/Blue Shield Alabama, Blue Cross/Blue Shield Massachusetts, CIGNA, HealthPartners, Humana, Medica, Regence, Wellmark, United Healthcare), all that had policies covered use of vemurafenib for its FDA-approved indication.[200,272-275] Additionally, at least two major third-party payers had specific policies that

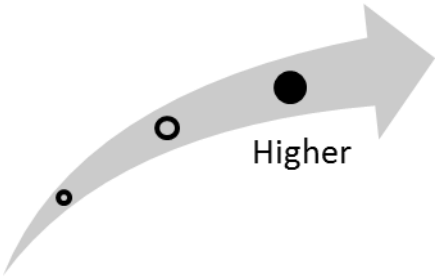
provide coverage for B-RAF^{V600} mutation analysis in individuals with unresectable or metastatic melanoma who are being considered for treatment with vemurafenib.[276,277]

A second B-RAF inhibitor has also reached phase III development: dabrafenib (GlaxoSmithKline, Middlesex, UK). This drug is described by the developer as highly potent and selective with more than 100 times the selectivity for mutant *B-RAF*.[278] The drug is purported to display dose-dependent inhibition of MEK and ERK phosphorylation in mutated *B-RAF* cell lines and to achieve tumor regression. It is being studied in a 200-patient, phase III trial for metastatic melanoma with results anticipated to be released in June 2012.[278] Pharmaceuticals that target other kinases in the RAS/MAP kinase pathway are also being developed, in particular MEK inhibitors (e.g., trametinib).[279] In addition to the potential for MEK inhibitors to be used as monotherapies, combination therapy with a B-RAF inhibitor and a MEK inhibitor may address one of the chief shortcomings of B-RAF-targeted therapy, the relatively rapid development of resistance to B-RAF inhibition.[279]

Clinical Pathway at Point of This Intervention

Patients in whom disseminated/unresectable, metastatic melanoma has been diagnosed are typically treated with one of a number of systemic therapies and/or radiation therapy.[262] Standard systemic therapies include dacarbazine, high-dose interleukin-2, ipilimumab, temozolomide, vemurafenib (for patients whose melanoma harbors an activating mutation in the *B-RAF* gene), or paclitaxel with or without cisplatin or carboplatin.[262] Patients maintaining sufficiently good health to undergo additional treatments may be treated sequentially with additional treatments.[262] Vemurafenib and ipilimumab have become standard first-line options in treating disseminated metastatic melanoma.[262]

Figure 13. Overall High Impact Potential: B-RAF kinase inhibitor (vemurafenib, Zelboraf) for treatment of metastatic melanoma



Overall, experts commenting on this drug class believe the availability of B-RAF inhibitors has potential to fundamentally change treatment paradigms for metastatic melanoma because they will split a single syndrome into *B-RAF* mutation-positive and *B-RAF* mutation-negative disease. This will necessitate testing of all patients to determine their *B-RAF* status. Experts opined that while the potential of B-RAF inhibitors is limited because it is unlikely to be a curative treatment and the vast majority of patients will eventually develop resistance to the therapy, these inhibitors are expected to be a central focus of melanoma treatment and clinical study in coming years. Based on this input, our overall assessment is that this intervention is in the higher end of the high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, health systems, and health administration perspectives, offered comments on vemurafenib.[280-286]

Experts were unanimous in their opinion that vemurafenib has potential to address an important unmet need, citing the poor prognosis and limited treatment options for patients with metastatic melanoma and the lack of other therapies targeting oncogenic *B-RAF*. Experts also believe that data from clinical trials indicated that vemurafenib has significant potential to improve patient outcomes, citing a significant increase in the response rate, duration of progression-free survival, and duration of overall survival, but that nearly all patients will eventually become refractory to this treatment and their disease will progress. One expert with a clinical perspective stated that vemurafenib was the only melanoma therapy that frequently generates a rapid tumor response and, therefore, has the potential to provide symptomatic relief to patients.

Experts did not think that the availability of vemurafenib would lead to a marked change in health disparities. One expert speaking from a clinical perspective suggested that an orally administered medication could be more easily administered by local oncologists compared with some other therapies (e.g., high-dose interleukin-2, ipilimumab) that will likely be administered in select centers and so would reach some previously underserved patients. Conversely, an expert with a health administration background suggested that the high cost of vemurafenib and the requirement for *B-RAF* genetic testing could place this treatment out of the reach of underserved patients lacking insurance coverage and/or the economic means to pay for treatment.

As an orally administered medication with a clear target patient population, vemurafenib is not likely to encounter many obstacles to adoption, experts believe. Several experts noted that while vemurafenib has a generally mild side-effect profile, significant side effects have been reported. In particular, the development of squamous cell carcinomas has been associated with B-RAF inhibitor treatment and would require that patients be monitored by a dermatologist. However, experts believe that side effects were typically manageable and, given the paucity of treatment options and the potential benefits of the treatment, the potential side effects would not dissuade significant numbers of patients or physicians from opting for treatment with vemurafenib. Indeed, one expert with a clinical perspective suggested that vemurafenib has already been adopted widely by patients and physicians.

The majority of experts suggested that the addition of vemurafenib to the clinical pathway for treating B-RAF-positive melanoma would lead to a moderate increase in the cost of care for this patient population. Additionally, experts suggested that the need to screen patients with melanoma for B-RAF status would add to the cost of treating this condition.

Hedgehog Pathway Inhibitor (Vismodegib, Erivedge) for Treatment of Basal Cell Carcinoma

Aberrant activation of the Hedgehog signaling pathway drives the development and survival of several tumor types, most prominently basal cell carcinoma, of which the large majority exhibit elevated levels of Hedgehog pathway activity.[287] While pharmacologic inhibition of the Hedgehog pathway would likely be of significant benefit to these patients for whom no consensus systemic treatment exists, no Hedgehog pathway inhibitor was available prior to the recent FDA approval of vismodegib.[288]

Vismodegib (Genentech subsidiary of F. Hoffmann-La Roche, Ltd., Basel, Switzerland) is an orally available, small-molecule antagonist of the Hedgehog pathway. Vismodegib functions by inhibiting a protein (called Smoothened) that is essential for transducing Hedgehog pathway activity.[289] In basal cell carcinomas, mutations may occur that cause constitutive activation of the Hedgehog pathway.[289] If these mutations affect the pathway at or above the level of Smoothened, vismodegib may be able to reduce the aberrant levels of Hedgehog pathway activity and inhibit tumor growth and/or survival.

A single-arm, phase II clinical trial (ERIVANCE BCC) was recently completed for vismodegib (150 mg once daily) in treating of 104 patients who had locally advanced and/or metastatic basal cell carcinoma inappropriate for surgical resection. The overall response rate, as assessed by independent review, was 43% in patients with locally advanced disease and 30% in patients with metastatic disease. Additionally, the median progression-free survival for both patient groups was 9.5 months.[290]

The most common adverse events reported in the trial included altered taste sensation, decreased appetite, diarrhea, fatigue, hair loss, muscle spasms, nausea, and weight loss. Additionally, serious adverse events were observed in 26 patients (25%) of which 4 (representing 4% of patients) were considered vismodegib-related.[290] These serious adverse events included one case each of blocked bile flow from the liver (cholestasis), dehydration with loss of consciousness (syncope), pneumonia accompanied by an inability of the heart to pump enough blood (cardiac failure), and a sudden arterial blockage in the lung (pulmonary embolism).[290]

Based on the data from this clinical trial, FDA granted marketing approval for vismodegib in January 2012.[288] The prescribing information for vismodegib indicates that the drug is intended for "the treatment of adults with metastatic basal cell carcinoma, or with locally advanced basal cell carcinoma that has recurred following surgery or who are not candidates for surgery, and who are not candidates for radiation."[291] A second phase II clinical trial of vismodegib in patients with operable basal cell carcinoma is ongoing.

Genentech announced that vismodegib's average wholesale cost will be $7,500 per month per patient, and the estimated duration of treatment is 10 months.[292] Third-party payers list the drug as a specialty pharmaceutical requiring prior authorization for reimbursement. Genentech's Access Solutions program facilitates access, including for patients who cannot afford the drug because of large copayments or lack of prescription drug insurance.[293]

Additional evidence for vismodegib's activity in basal cell carcinoma comes from an investigator-sponsored trial in patients with basal cell nevus syndrome, a genetic condition in which a hereditary defect leads to the formation of large numbers of basal cell carcinomas that each require surgical extirpation.[294] In this 41-patient trial, treatment with vismodegib (150 mg once daily) was compared with treatment with placebo for its ability to prevent the formation of new basal cell carcinomas. An interim analysis indicated that patients treated with vismodegib developed

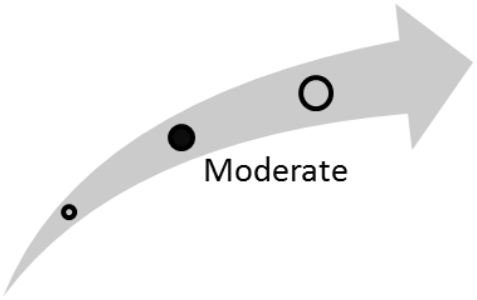
0.07 new basal cell carcinomas per month compared to 1.74 basal cell carcinomas in patients receiving placebo ($p < 0.0001$).[294] Additionally, vismodegib was reported as leading to a significant reduction in the size of existing basal cell carcinomas.[294]

Vismodegib and other Hedgehog pathway inhibitors are under study in a wide range of cancers besides basal cell carcinoma.

Clinical Pathway at Point of This Intervention

Most basal cell carcinomas are identified as superficial skin lesions and can typically be treated by surgical resection.[287,295] An alternative primary treatment for these lesions is radiation therapy; however, this treatment is typically reserved for patients older than 60 years of age because of concerns about the potential for collateral tissue damage.[295] Lastly, superficial treatments (e.g., photodynamic therapy, cryotherapy, topical chemotherapy) with lower reported cure rates than surgery or radiation therapy might be an option for patients unwilling or unable to undergo surgery or radiation therapy.[295] For basal cell carcinomas that become locally advanced and inoperable or become metastatic, there is no clear consensus on treatment options.[295] Treatments include radiation therapy and various systemic chemotherapy options, typically platinum-based cytotoxic regimens.[295] If approved, vismodegib would provide a new pharmacotherapy option for patients with inoperable/metastatic basal cell carcinomas.[296,297]

Figure 14. Overall High Impact Potential: Hedgehog pathway inhibitor (vismodegib) for treatment of basal cell carcinoma



Overall, experts commenting on this intervention believe that vismodegib has significant potential to affect the treatment of basal cell carcinoma as a first-in-class agent that has demonstrated compelling response rates in a patient population lacking a systemic treatment option. However, experts were cautious regarding vismodegib's potential to improve patient health outcomes because of the lack of long-term followup data. Additionally, experts believe that vismodegib's impact on the health system as a whole would be limited by the small target patient population. Based on this input, our overall assessment is that this intervention is in the moderate high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, and health systems backgrounds, offered perspectives on this intervention.[298-304] Experts thought the unmet need that vismodegib could address is moderately or very important, citing both the lack of effective systemic treatments for advanced/metastatic basal cell carcinoma and the fact that vismodegib represents a first-in-class inhibitor of the Hedgehog signaling pathway.

Experts also rated the potential for vismodegib to improve patient health outcomes as moderate to large, citing the relatively high response rates to vismodegib therapy reported in the clinical trial for a patient population with few treatment options. One expert with a clinical perspective observed that vismodegib could be used to downstage large, basal cell carcinomas for which surgery would cause significant morbidity and noted that no effective neoadjuvant therapy is available. Experts suggested that vismodegib would be readily adopted by physicians and patients alike, citing the lack of viable treatment alternatives for patients with unresectable basal cell carcinoma. However, two experts suggested that some patients may be hesitant to opt for a therapy with such high rate of side effects, citing the fact that many patients discontinued treatment in the clinical trials of vismodegib. While experts were enthusiastic regarding the preliminary data on vismodegib's antitumor activity, several experts noted the preliminary nature of these findings, especially with regard to potential long-term side effects of vismodegib treatment.

The majority of experts did not think vismodegib would have a significant impact on health disparities. One expert with a clinical perspective suggested that patients presenting with advanced or unresectable basal cell carcinomas tend to be underserved by the health care system and that vismodegib, which is likely to be an expensive treatment and potentially unavailable to some underserved patients, could worsen this disparity.

Because vismodegib is an orally administered drug that would be taken in the outpatient setting, it would not have significant impacts on health care delivery infrastructure or staffing, the majority of experts thought. However, several experts noted that the way in which patients are managed could be changed in that some patients would be referred to medical oncologists whereas they would not have been previously, given the lack of systemic therapy options.

While experts thought that adoption of vismodegib for treating basal cell carcinoma would likely increase the cost of treating these patients, the system-level effect of these costs was seen as minimal because of the relatively small number of patients who have unresectable basal cell carcinoma each year.

Ipilimumab (Yervoy) for Treatment of Metastatic Melanoma

According to the American Academy of Dermatology, more than half of all new cases of melanoma in the United States in 2010 were invasive at the time of diagnosis.[260] Until recently, guidelines from the National Comprehensive Cancer Network indicated that no clearly optimal treatments for metastatic melanoma were available, and there was little consensus on standard therapy.[261] The recent approval of ipilimumab (Yervoy™, Bristol-Myers Squibb, New York, NY) and vemurafenib for treating metastatic melanoma have provided the first treatments that generate any improved survival for this patient population.

Ipilimumab is a cytotoxic T-lymphocyte antigen 4 (CTLA-4)-blocking monoclonal antibody intended for treating unresectable or metastatic melanoma. The molecular target of ipilimumab (CTLA-4) is thought to function as a negative regulator of T cell stimulation. By limiting T cell activation, CTLA-4 activity may play a role in immune system homeostasis, limiting the magnitude of an immune response and the potential for autoimmune reactions; however, these inhibitory activities may also lead to immune system tolerance of cancer cells. By inhibiting the action of CTLA-4, ipilimumab is believed to increase T-cell activity, resulting in increased antitumor responses generated by the patient's immune system.[305,306]

In a clinical trial, patients with unresectable stage III or IV melanoma (n=676) whose disease had progressed during therapy were randomly assigned to receive ipilimumab plus an experimental peptide vaccine gp100 (n=403), ipilimumab alone (n=137), or gp100 alone (n=136). Ipilimumab, at a dose of 3 mg/kg of body weight, was administered with or without gp100 every 3 weeks for up to four treatments (induction). The median overall survival was 10.0 months among patients receiving ipilimumab plus gp100, compared with 6.4 months among patients receiving gp100 alone (hazard ratio [HR] for death 0.68; $p < 0.001$). The median overall survival with ipilimumab alone was 10.1 months (HR for death compared with gp100 alone 0.66, $p=0.003$).[307] In March 2011, FDA granted Bristol-Myers Squibb marketing approval of ipilimumab for treating advanced melanoma.[308] Ipilimumab has a black box warning regarding the development of fatal immune-mediated adverse reactions due to T-cell activation and proliferation, which may involve any organ system; the most common reactions include dermatitis, endocrinopathy, enterocolitis, hepatitis, and neuropathy.[309]

Ipilimumab has also been studied in patients with treatment-naïve metastatic melanoma.[310] A 502-patient, phase III clinical trial investigated the efficacy of ipilimumab in combination with the standard first-line chemotherapy agent dacarbazine compared with dacarbazine plus placebo in treating metastatic melanoma. Results published in June 2011 indicated that treatment with ipilimumab plus dacarbazine exhibited a small but statistically significant improvement in the duration of overall survival compared with dacarbazine alone (11.2 months vs. 9.1 months).[310] Estimated survival rates of the ipilimumab-dacarbazine and dacarbazine-placebo groups were 47.3% and 36.3% at 1 year, 28.5% and 17.9% at 2 years, and 20.8% and 12.2% at 3 years (HR for death with ipilimumab-dacarbazine 0.72, $p < 0.001$).[310]

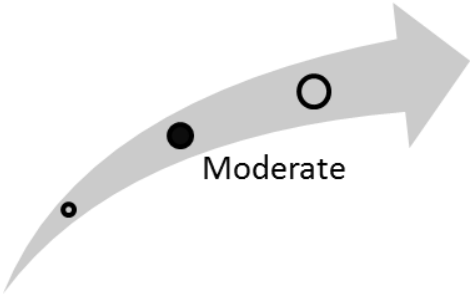
The drug's estimated per patient cost is $120,000 for a full course (4 infusions).[311] Among 11 major, private, third-party payers that publish their policies online (i.e., Aetna, Anthem, Blue Cross/Blue Shield Alabama, Blue Cross/Blue Shield Massachusetts, CIGNA, HealthPartners, Humana, Medica, Regence, Wellmark, United Healthcare), policies identified regarding ipilimumab indicated that third-party payers covered the use of ipilimumab in treating unresectable or metastatic melanoma.[312-316] The U.S. Centers for Medicare & Medicaid has assigned a Healthcare Common Procedure Coding System (HCPCS) code that describes injection of ipilimumab.[317] Bristol-Myers Squibb may provide support to patients unable to afford treatment with ipilimumab through its Yervoy (ipilimumab) Patient Assistance Program.[318]

The efficacy of ipilimumab has demonstrated the potential of immune checkpoint modulators in melanoma specifically and cancer more generally. Additional therapies targeting immune checkpoints (e.g., programmed cell death protein 1 [PD1] pathway) are under study in various anticancer indications.[319]

Clinical Pathway at Point of This Intervention

Patients in whom disseminated/unresectable metastatic melanoma has been diagnosed are typically treated with one of a number of systemic therapies and/or radiation therapy.[262] Standard systemic therapies include ipilimumab, vemurafenib (for patients whose melanoma harbors an activating mutation in the *B-RAF* gene), dacarbazine, temozolomide, high-dose interleukin-2, or paclitaxel with or without cisplatin or carboplatin.[262] Patients with good enough health to undergo additional treatments may be treated sequentially with additional treatments.[262] Ipilimumab, along with vemurafenib, have become standard first-line options in treating disseminated metastatic melanoma.[262]

Figure 15. Overall High Impact Potential: Ipilimumab (Yervoy) for treatment of metastatic melanoma



Experts commenting on this intervention thought that clinical trials of ipilimumab demonstrated that the drug had a significant potential to meet an important unmet need for therapies that could improve overall survival in metastatic melanoma. However, this enthusiasm was tempered by the relatively small number of patients who achieve long-term benefit from the drug and the potential for serious adverse events. Despite these caveats, experts believe that ipilimumab would be widely adopted and that the high cost the therapy would have a significant impact on the cost of care for this patient population. Based on this input, our overall assessment is that this intervention is in the moderate high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, health systems, and health administration backgrounds, offered comments on this intervention.[320-326]

Experts unanimously suggested that advanced melanoma represents a very important unmet need, citing the short duration of survival for patients with this condition and the unavailability of treatments that had demonstrated an improvement in overall survival prior to the recent FDA approval of ipilimumab and the B-RAF inhibitor vemurafenib. The majority of experts believed that the demonstration of improved overall survival in clinical trials involving more than 1,000 patients suggested that ipilimumab had a significant potential to improve the health of patients with metastatic melanoma. In particular, multiple experts with a clinical perspective noted the potential of ipilimumab to generate durable responses, albeit in a small subset of treated patients. Experts who had a less favorable opinion of ipilimumab's potential to improve patient health noted the low

overall response rate to ipilimumab therapy and the potential for severe autoimmune-related adverse events.

The majority of experts did not envision that ipilimumab would have a significant impact on health disparities. If anything, experts suggested that the availability of ipilimumab had the potential to exacerbate health disparities. Experts cited the high cost of the therapy and the need to travel to an infusion center as barriers that could limit the availability of ipilimumab to underserved patient populations.

The majority of experts did not envision that ipilimumab would lead to a significant shift in health care facility staffing or infrastructure, given that ipilimumab would be administered in a manner consistent with other intravenous cancer therapies. However, multiple experts suggested that patient management would need to be altered to allow for monitoring and treatment of emergent autoimmune events associated with ipilimumab treatment. One expert with a clinical perspective suggested that the unpredictable and potentially severe nature of adverse events could limit adoption of ipilimumab therapy to large practice groups and academic centers. However, despite this caveat, this clinical reviewer concurred with the majority of experts who suggested that ipilimumab would be widely adopted by both patients and physicians alike based on the lack of viable alternative treatments (particularly in patients whose disease does not harbor a B-RAF mutation and, therefore, are ineligible for vemurafenib treatment).

Experts agreed that ipilimumab would likely add to the cost of care. Some experts stated that the cost-benefit ratio combined with the potential for life-threatening adverse events may lead to controversy regarding the drug and barriers to its acceptance. One expert with a clinical perspective suggested that the high cost and relatively low response rate would likely lead to studies that attempt to identify patient subgroups that are more likely to respond to ipilimumab therapy. This clinician also suggested that some of the initial enthusiasm for ipilimumab had waned as clinicians and patients looked ahead to other immunotherapies in development.

Thyroid Cancer Interventions

Multikinase Inhibitors (Vandetanib and Cabozantinib) for Treatment of Metastatic Medullary Thyroid Cancer

Medullary thyroid cancer is a rare form of thyroid cancer arising from the calcitonin-producing parafollicular (C cells) of the thyroid.[327] Only about 1,500 cases of medullary thyroid cancer are diagnosed per year in the United States, representing about 3% of thyroid malignancies; however, about 13% of thyroid-cancer-related deaths are caused by medullary thyroid cancer, reflecting the paucity of effective treatment options for this condition.[328,329] In April 2011, FDA approved vandetanib (Caprelsa®) as the first, and thus far only medication indicated for treating medullary thyroid cancer. Vandetanib is a small-molecule, tyrosine kinase inhibitor developed by AstraZeneca (London, UK). The drug has activity against multiple receptor tyrosine kinases, including RET (rearranged during transfection), vascular endothelial growth factor receptor 2 (VEGFR2), and the epidermal growth factor receptor (EGFR).[330] Each of these receptor tyrosine kinases has been shown to regulate pathways controlling cell growth and proliferation, angiogenesis, and cell survival, and their inhibition has demonstrated antineoplastic activity in treating various cancers.[329] With regard to medullary thyroid cancer, aberrant RET signaling has been directly implicated in the pathogenesis of the disease; mutant versions of the RET gene encoding activated forms of the receptor tyrosine kinase have been identified in both hereditary and sporadic forms of the disease and correlations have been made between the type of RET mutation present in an individual and the severity of thyroid tumors occurring in hereditary forms of the disease.[327,329] Therefore, tyrosine kinase inhibitors with activity against RET (e.g., vandetanib, sorafenib, sunitinib, motesanib, cabozantinib) represent promising treatment options for medullary thyroid cancer.[329]

In October 2011, results were published from a double-blind, placebo-controlled study of vandetanib in treating 331 patients who had locally advanced or metastatic medullary thyroid cancer.[331] At a median followup of 24 months, patients in the vandetanib arm (n=231) demonstrated a significant improvement in the duration of progression-free survival compared with patients in the placebo arm (n=100; HR, 0.46; 95% confidence interval [CI], 0.31 to 0.69).[331] While, researchers attempted to correlate RET mutational status with treatment efficacy, the prescribing information for vandetanib states that no evidence exists of a relationship between RET mutational status and efficacy of treatment.[327,332] No significant difference in the duration of overall survival had been observed at the time of publication, and while overall survival will continue to be monitored, the result may be obscured by crossover of patients from the placebo arm to treatment with vandetanib.[327]

The prescribing information for vandetanib carries a black box warning regarding the risks of heart rhythm abnormalities (QT prolongation, torsades de pointes) and sudden death.[332] Only prescribers and pharmacies certified through the manufacturer's Risk Evaluation and Mitigation Strategy (REMS) program, a restricted distribution program, are allowed to prescribe and dispense vandetanib.[333] Additional commonly reported adverse events included diarrhea, hypertension, headache, nausea, and rash.[331] Because tyrosine kinase inhibitors might be taken over an extended period of time during disease management, adverse events will need to be monitored and managed carefully.

Reported cost of a 30-day supply of 300 mg vandetanib is more than $10,000. The company created an affordable access program to help patients obtain the drug. Third-party payers list the drug as a specialty pharmaceutical requiring prior authorization.

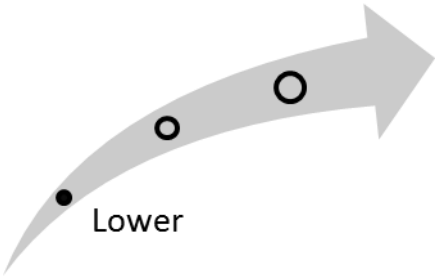
A second tyrosine kinase inhibitor, cabozantinib (Exelixis, Inc., South San Francisco, CA), which has activity against RET, VEGFR2, and MET receptor tyrosine kinases has also reached late

stages of development.[334] In a phase III clinical trial, cabozantinib met its primary endpoint of improving progression-free survival compared with placebo (HR, 0.28; 95% CI, 0.19 to 0.40, p <0.0001) in patients with medullary thyroid cancer.[335] In this trial, the most frequent adverse events of grade 3 or higher were diarrhea (15.9% cabozantinib arm vs. 1.8% placebo arm), hand-foot syndrome (12.6% cabozantinib vs. 0% placebo), fatigue (9.3% cabozantinib vs. 2.8% placebo), hypocalcemia (9.3% cabozantinib vs. 0% placebo), and hypertension (7.9% cabozantinib vs. 0% placebo).[335] The company expected to complete an NDA filing with FDA in the first half of 2012.[334]

Clinical Pathway at Point of This Intervention

Patients in whom locally advanced unresectable or metastatic medullary thyroid cancer has been diagnosed have few treatment options. Patients may undergo palliative locoregional treatments such as external beam radiation therapy, radiofrequency ablation, or embolization. Alternatively, patients may undergo treatment with vandetanib, especially in cases of symptomatic or progressive disease.[336] Patients who present with or progress to disseminated symptomatic disease may undergo treatment with vandetanib or, in the case of unavailability of vandetanib or disease progression on vandetanib, other small-molecule, kinase inhibitors (e.g., sorafenib, sunitinib) or dacarbazine-based cytotoxic chemotherapy.[336]

Figure 16. Overall High Impact Potential: Multikinase inhibitors (vandetanib and cabozantinib) for treatment of metastatic medullary thyroid cancer



Overall, experts commenting on this intervention thought that vandetanib and cabozantinib for treating metastatic medullary thyroid cancer represent a significant improvement in the available treatment options for this patient population, given the prior lack of effective systemic therapy options. However, experts believe that the small medullary thyroid cancer patient population eligible for this treatment and the routine nature of its administration would limit the impact of the drugs for on the health care system as a whole. Based on this input, our overall assessment is that this intervention is in the lower end of the high-potential-impact range.

Results and Discussion of Comments

Seven experts, with clinical, research, and health systems backgrounds, offered perspectives on the topic of vandetanib for treating medullary thyroid cancer.[337-343]

From the perspective of the unmet need for systemic treatments for metastatic medullary thyroid cancer, experts agreed that before vandetanib was approved, a significant unmet need existed, citing the lack of efficacious systemic treatments for this condition. However, several experts noted the small number of patients who have medullary thyroid cancer and suggested that a treatment for this condition would have limited impact on the health care system as a whole.

While one expert with a clinical perspective rated vandetanib's potential to improve patient health as large, other experts viewed the potential as only minimal to moderate. While all experts pointed to vandetanib's reported effect of increasing the duration of progression-free survival, experts viewing vandetanib's potential more skeptically noted the significant side effects associated with treatment and questioned whether the demonstrated increase in progression-free survival would translate to a significant increase in the duration of overall survival.

Generally, experts did not think that the availability of vandetanib would have a large impact on health disparities. Experts who thought there would be a shift believe that the high cost and limited availability of the drug through the REMS program could worsen health disparities by further limiting access to treatment for underserved patient populations.

Vandetanib is the first systemic treatment to demonstrate a clear benefit in this patient population; experts anticipated that both patients and physicians would readily adopt its use in spite of the potential for significant adverse events. Experts did not anticipate that patient treatment with vandetanib, an orally administered medication, would require significant changes to the health care delivery infrastructure or the manner in which patients are managed.

As a novel medication that would likely be administered over a significant period of time, vandetanib has a moderate to large potential to increase the cost of care for patients with medullary thyroid cancer, the majority of experts thought. However, experts also noted that the small number of patients presenting with metastatic medullary thyroid cancer each year would limit the impact of these costs on the health care system as a whole.

Six experts, with clinical, research, and health systems backgrounds, offered perspectives on the topic of cabozantinib for treating medullary thyroid cancer.[344-349] Expert comments on the potential of cabozantinib for treating medullary thyroid cancer were for the most part similar to those for vandetanib, reflecting the highly similar nature of the two drugs. While a few experts noted that the availability of vandetanib diminished the unmet need that cabozantinib could fill, one expert with a clinical perspective suggested that both patients and physicians would welcome additional treatment options.

References

1. Breast cancer: early detection. Atlanta (GA): American Cancer Society; 2010. 33 p.
2. Smith A. Fundamentals of breast tomosynthesis [WP-00007]. Bedford (MA): Hologic, Inc.; 2008 Jun. 8 p.
3. U.S. Food and Drug Administration (FDA). Sponsor executive summary: P080003 Hologic Selenia Dimensions 3D system. Rockville (MD): U.S. Food and Drug Administration (FDA); 46 p. Also available: http://www.fda.gov.
4. Hologic receives FDA approval for first 3-D digital mammography (breast tomosynthesis) system. [internet]. Bedford (MA): Hologic, Inc.; 2011 Feb 11 [accessed 2011 May 17]. [3 p]. Available: http://www.hologic.com/en/news-releases/view/173-year.2011_173-id.234881803.html.
5. Chakrabarti K, Ochs R, Pennello G, et al. FDA executive summary: P080003 Hologic Selenia Dimensions 3D system. Silver Spring (MD): U.S. Food and Drug Administration (FDA); 2010 Sep 24. 34 p. Also available: http://www.fda.gov.
6. ECRI Institute. Breast tomosynthesis [guidance article]. Health Devices 2011 Aug:258-62.
7. Darcey S. Hologic looks to clinical reports to support reimbursement hike for 3D mammo. Gray Sheet 2011 Aug 8.
8. ECRI Institute. Computer-aided detection mammography for breast cancer screening. Plymouth Meeting (PA): ECRI Institute; 68 p. (Evidence report; no. 179).
9. Aetna, Inc. Clinical policy bulletin no. 0584: mammography. [internet]. Hartford (CT): Aetna, Inc.; 2011 Oct 7 [accessed 2012 Jan 5]. [15 p]. Available: http://www.aetna.com/cpb/medical/data/500_599/0584.html.
10. Anthem Insurance Companies, Inc. Medical policy: digital breast tomosynthesis. [internet]. Indianapolis (IN): Anthem Insurance Companies, Inc.; 2011 Oct 12 [accessed 2012 Jan 5]. [4 p]. Available: http://www.anthem.com/medicalpolicies/policies/mp_pw_c142751.htm.
11. Blue Cross Blue Shield of Alabama. Digital breast tomosynthesis [policy no. 252]. [internet]. East Birmingham (AL): Blue Cross Blue Shield of Alabama; 2011 Mar [accessed 2012 Jan 5]. [7 p]. Available: www.bcbsal.org.
12. Blue Cross and Blue Shield of Massachusetts. Digital breast tomosynthesis. Policy #327. [internet]. Rockland (MA): Blue Cross and Blue Shield of Massachusetts; 2011 Dec 1 [accessed 2012 Jan 5]. [3 p]. Available: http://www.bcbsma.com.
13. CIGNA Corporation. Mammography. Coverage policy number 0123. Bloomfield (CT): CIGNA Corporation; 2010 Oct. 12 p. Also available: http://www.cigna.com/customer_care/healthcare_professional/coverage_positions.
14. Humana, Inc. Breast imaging. Policy number CLPD-0503-002. Louisville (KY): Humana, Inc.; 2011 Sep 22. 19 p.
15. United HealthCare Services, Inc. Breast imaging for screening and diagnosing cancer. Policy number: 2011T0375H. [internet]. Minnetonka (MN): United HealthCare Services, Inc.; 2011 May 1 [accessed 2012 Jan 5]. [13 p]. Available: https://www.unitedhealthcareonline.com/ccmcontent/ProviderII/UHC/en-US/Assets/ProviderStaticFiles/ProviderStaticFilesPdf/Tools%20and%20Resources/Policies%20and%20Protocols/Medical%20Policies/Medical%20Policies/Breast_Imaging_for_Screening_and_Diagnos.
16. Learn about cancer: breast cancer detailed guide. [internet]. Atlanta (GA): American Cancer Society, Inc.; [accessed 2012 Feb 13]. [2 p]. Available: http://www.cancer.org/Cancer/BreastCancer/DetailedGuide/index.
17. Expert Commenter 145. (External, Clinical). Horizon Scanning Structured Comment Form. HS9 - 3D tomosynthesis (Hologic Selenia Dimensions) system for mammography screening. 2011 Mar 18 [review date].
18. Expert Commenter 347. (External, Research/Scientific/Technical). Horizon Scanning Structured Comment Form. HS9 - 3D tomosynthesis (Hologic Selenia Dimensions) system for mammography screening. 2012 Feb 24 [review date].
19. Expert Commenter 231. (External, Clinical). Horizon Scanning Structured Comment Form. HS9 - 3D tomosynthesis (Hologic Selenia Dimensions) system for mammography screening. 2012 Feb 20 [review date].
20. Expert Commenter 394. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS9 - 3D tomosynthesis

(Hologic Selenia Dimensions) system for mammography screening. 2012 Mar 15 [review date].

21. Expert Commenter 421. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS9 - 3D tomosynthesis (Hologic Selenia Dimensions) system for mammography screening. 2012 Mar 15 [review date].
22. Expert Commenter 406. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS9 - 3D tomosynthesis (Hologic Selenia Dimensions) system for mammography screening. 2012 Mar 15 [review date].
23. Expert Commenter 416. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS9 - 3D tomosynthesis (Hologic Selenia Dimensions) system for mammography screening. 2012 Mar 15 [review date].
24. Expert Commenter 546. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS9 - 3D tomosynthesis (Hologic Selenia Dimensions) system for mammography screening. 2012 Feb 27 [review date].
25. McCahill LE, Single RM, Aiello Bowles EJ, et al. Variability in reexcision following breast conservation surgery. JAMA 2012 Feb 1;307(5):467-75. PMID: 22298678
26. Dune Medical's MarginProbe demonstrates increased positive margin identification leading to reduction in patients indicated for re-excision in landmark lumpectomy surgery trial. [internet]. Framingham (MA): Dune Medical Devices Inc.; [accessed 2011 Jul 22]. [2 p]. Available: http://dunemedical.com/dune/wp-content/uploads/2011/05/ASBS-Data-Press-Release_FINAL.pdf.
27. Detecting cancer by discerning bioelectric differences. [internet]. Framingham (MA): Dune Medical Devices Inc.; [accessed 2011 Jul 22]. [1 p]. Available: http://dunemedical.com/rf-spectroscopy/.
28. Fringe field sensor. [internet]. Framingham (MA): Dune Medical Devices Inc.; [accessed 2011 Jul 22]. [1 p]. Available: http://dunemedical.com/rf-spectroscopy/.
29. The formula for differentiating tissue. [internet]. Framingham (MA): Dune Medical Devices Inc.; [accessed 2011 Jul 22]. [1 p]. Available: http://dunemedical.com/rf-spectroscopy/.
30. Schnabel F, Tafra L, The MarginProbe Study Group. A randomized, prospective, multicenter study of the impact of intraoperative margin assessment with adjunctive use of MarginProbe vs. standard of care [abstract PD02-04]. Cancer Res 2011 Dec 15;71(24 suppl):122s.
31. FDA formally accepts Dune Medical's MarginProbe system pre-market approval (PMA) application and grants expedited review status. [internet]. Framingham (MA): Dune Medical Devices, Inc.; 2011 May 16 [accessed 2011 Jul 22]. [1 p]. Available: http://dunemedical.com/dune/wp-content/uploads/2011/06/PMA-filing-Press-Release-final.pdf.
32. June 21, 2012: general and plastic surgery devices panel of the Medical Devices Advisory Committee meeting announcement. [internet]. Silver Spring (MD): U.S. Food and Drug Administration (FDA); [accessed 2012 May 17]. [2 p]. Available: http://www.fda.gov/AdvisoryCommittees/Calendar/ucm298402.htm.
33. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology: breast cancer. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2010 Jan 1. 132 p.
34. Expert Commenter 1066. (External, Clinical). Horizon Scanning Structured Comment Form. HS1055 - MarginProbe System for intraoperative identification of positive margins during breast cancer lumpectomy. 2012 Apr 24 [review date].
35. Expert Commenter 229. (External, Clinical). Horizon Scanning Structured Comment Form. HS1055 - MarginProbe System for intraoperative identification of positive margins during breast cancer lumpectomy. 2012 Apr 2 [review date].
36. Expert Commenter 676. (PRI, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS1055 - MarginProbe System for intraoperative identification of positive margins during breast cancer lumpectomy. 2012 Apr 19 [review date].
37. Expert Commenter 394. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS1055 - MarginProbe System for intraoperative identification of positive margins during breast cancer lumpectomy. 2012 Apr 10 [review date].
38. Expert Commenter 421. (ECRI Institute, Technology Assessment). Horizon Scanning

Structured Comment Form. HS1055 - MarginProbe System for intraoperative identification of positive margins during breast cancer lumpectomy. 2012 Apr 10 [review date].

39. Expert Commenter 1174. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS1055 - MarginProbe System for intraoperative identification of positive margins during breast cancer lumpectomy. 2012 Apr 10 [review date].

40. Expert Commenter 423. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS1055 - MarginProbe System for intraoperative identification of positive margins during breast cancer lumpectomy. 2012 Apr 10 [review date].

41. Foster KG, Fingar DC. Mammalian target of rapamycin (mTOR): conducting the cellular signaling symphony. J Biol Chem 2010 May 7;285(19):14071-7. PMID: 20231296

42. Torisel kit (temsirolimus) injection, for intravenous infusion only - highlights of prescribing information. Philadelphia (PA): Wyeth Pharmaceuticals, Inc; 2011 Jun. 24 p.

43. Specialty TrendsRx alert: afinitor (everolimus). Richardson (TX): CVS Caremark; 2009. 2 p. Also available: https://www.caremark.com/portal/asset/SpecialtyTrendsRxAlert_Afinitor.pdf.

44. Novartis Pharmaceuticals. Everolimus in combination with exemestane in the treatment of postmenopausal women with estrogen receptor positive locally advanced or metastatic breast cancer who are refractory to letrozole or anastrozole (BOLERO-2). In: ClinicalTrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2011 Aug 1]. [4 p]. Available: http://www.clinicaltrials.gov/ct2/show/NCT00863655 NLM Identifier: NCT00863655.

45. Novartis drug Afinitor met primary endpoint of phase III study in women with advanced breast cancer; potential to address significant unmet need. [internet]. Basel (Switzerland): Novartis; 2011 Jul 5 [accessed 2011 Aug 1]. [6 p]. Available: http://www.novartisoncology.com/media/press-releases.jsp?id=1528340&year=2011&page=1.

46. Bachelot T, Bourgier C, Cropet C, et al. A GINECO randomized phase II trial of everolimus in combination with tamoxifen versus tamoxifen alone in patients (pts) with hormone-receptor positive, HER2 negative metastatic breast cancer (MBC) with prior exposure to aromatase inhibitors (AI). In: 33rd San Antonio Breast Cancer Symposium; 2010 Dec 8-12; San Antonio (TX). Also available: http://www.abstracts2view.com/sabcs10/view.php?nu=SABCS10L_230.

47. Baselga J, Campone M, Piccart M, et al. Everolimus in postmenopausal hormone-receptor-positive advanced breast cancer. N Engl J Med 2012 Feb 9;366(6):520-9. PMID: 22149876

48. Novartis Pharmaceuticals. Everolimus in combination with trastuzumab and paclitaxel in the treatment of HER2 positive locally advanced or metastatic breast cancer (BOLERO-1). In: ClinicalTrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2011 Sep 9]. [5 p]. Available: http://www.clinicaltrials.gov/ct2/show/NCT00876395 NLM Identifier: NCT00876395.

49. Novartis Pharmaceuticals. Daily everolimus in combination with trastuzumab and vinorelbine in HER2/neu positive women with locally advanced or metastatic breast cancer (BOLERO-3). In: ClinicalTrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2011 Sep 9]. [4 p]. Available: http://www.clinicaltrials.gov/ct2/show/NCT01007942 NLM Identifier: NCT01007942.

50. Termination of phase 3 clinical program with oral temsirolimus in women with metastatic breast cancer. [internet]. Philadelphia (PA): Wyeth Pharmaceuticals, Inc; 2006 Mar 21 [accessed 2011 Nov 15]. [4 p]. Available: http://phx.corporate-ir.net/phoenix.zhtml?c=78193&p=irol-newsArticle&ID=832781&highlight=.

51. Novartis International AG. Novartis Q1 2012 interim financial report - supplementary data. Basel (Switzerland): Novartis International AG; 2012. 47 p. Also available: http://www.novartis.com/downloads/investors/financial-results/quarterly-results/q1-2012-interim-financial-report-en.pdf.

52. RxUSA.com [database online]. [accessed 2011 Mar 10]. Available: http://rxusa.com/cgi-bin2/db/db.cgi.

53. Expert Commenter 401. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS1155 - An mTOR inhibitor (everolimus) for treatment of estrogen receptor-positive breast cancer. 2011 Oct 19 [review date].

54. Expert Commenter 419. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS1155 - An mTOR inhibitor (everolimus) for treatment of estrogen receptor-positive breast cancer. 2011 Oct 24 [review date].

55. Expert Commenter 441. (PRI, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS1155 - An mTOR inhibitor (everolimus) for treatment of estrogen receptor-positive breast cancer. 2011 Oct 25 [review date].

56. Expert Commenter 394. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS1155 - An mTOR inhibitor (everolimus) for treatment of estrogen receptor-positive breast cancer. 2011 Oct 13 [review date].

57. Expert Commenter 993. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS1155 - An mTOR inhibitor (everolimus) for treatment of estrogen receptor-positive breast cancer. 2011 Oct 24 [review date].

58. Expert Commenter 146. (External, Clinical). Horizon Scanning Structured Comment Form. HS1155 - An mTOR inhibitor (everolimus) for treatment of estrogen receptor-positive breast cancer. 2011 Oct 25 [review date].

59. Expert Commenter 1066. (External, Clinical). Horizon Scanning Structured Comment Form. HS1155 - An mTOR inhibitor (everolimus) for treatment of estrogen receptor-positive breast cancer. 2011 Oct 25 [review date].

60. Pruthi S. HER2-positive breast cancer: what is it? [internet]. Rochester (MN): Mayo Foundation for Medical Education and Research (MFMER); 2010 Feb 20 [accessed 2011 Feb 18]. Available: http://www.mayoclinic.com/health/breast-cancer/AN00495.

61. Fang L, Barekati Z, Zhang B, et al. Targeted therapy in breast cancer: what's new? Swiss Med Wkly 2011;141:w13231. PMID: 21706452

62. Isakoff SJ, Baselga J. Trastuzumab-DM1: building a chemotherapy-free road in the treatment of human epidermal growth factor receptor 2-positive breast cancer. J Clin Oncol 2011 Feb 1;29(4):351-4. PMID: 21172881

63. New phase II study showed trastuzumab-DM1 shrank tumors in women with highly advanced HER2-positive breast cancer. [internet]. San Antonio (TX): Genentech USA, Inc.; 2009 Dec 12 [accessed 2011 Feb 18]. [2 p]. Available: http://www.gene.com/gene/news/press-releases/display.do?method=detail&id=12527.

64. Roche's investigational medicine T-DM1 shows improvement in progression-free survival compared to standard of care in HER2-positive metastatic breast cancer. [internet]. Basel (Switzerland): Roche; 2011 Sep 25 [accessed 2011 Sep 27]. [3 p]. Available: http://www.roche.com/media/media_releases/med-cor-2011-09-25.htm.

65. Investor update: Roche's trastuzumab emtansine (T-DM1) showed positive phase III results in HER2-positive metastatic breast cancer. [internet]. Basel (Switzerland): Roche; 2012 Mar 30 [accessed 2012 May 17]. [2 p]. Available: http://www.roche.com/investors/ir_update/inv-update-2012-03-30.htm.

66. Pharmaceuticals pipeline. [internet]. Basel (Switzerland): F. Hoffmann-La Roche Ltd.; [accessed 2011 Aug 16]. [3 p]. Available: http://www.roche.com/research_and_development/pipeline/roche_pharma_pipeline.htm.

67. Genentech provides update on FDA application for T-DM1. [internet]. South San Francisco (CA): Genentech USA, Inc.; 2010 Aug 26 [accessed 2011 Feb 18]. [3 p]. Available: http://www.gene.com/gene/news/press-releases/display.do?method=detail&id=12947.

68. Pertuzumab combined with herceptin and chemotherapy significantly extended the time people with HER2-positive metastatic breast cancer lived without their disease getting worse. [internet]. Basel (Switzerland): Roche; 2011 Jul 15 [accessed 2011 Aug 3]. [3 p]. Available: http://www.roche.com/media/media_releases/med-cor-2011-07-15.htm.

69. Baselga J, Gelmon KA, Verma S, et al. Phase II trial of pertuzumab and trastuzumab in patients with human epidermal growth factor receptor 2-positive metastatic breast cancer that progressed during prior trastuzumab therapy. J Clin Oncol 2010 Mar 1;28(7):1138-44. PMID: 20124182

70. Baselga J, Cortes J, Kim SB,et al. Pertuzumab plus trastuzumab plus docetaxel for metastatic breast cancer. N Engl J Med 2012 Jan 12;366(2):109-19. Epub 2011 Dec 7. PMID: 22149875

71. FDA grants Genentech's pertuzumab priority review for previously untreated HER2-positive metastatic breast cancer. [internet]. South San Francisco (CA): Genentech USA, Inc.; 2012 Feb 7 [accessed 2012 Apr 10]. [3 p]. Available: http://www.gene.com/gene/news/press-releases/display.do?method=detail&id=13847.

72. Expert Commenter 419. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS460 - Trastuzumab-DM1 antibody-drug conjugate for treatment of breast cancer. 2012 Apr 10 [review date].

73. Expert Commenter 419. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS460 - Trastuzumab-DM1 antibody-drug conjugate for treatment of breast cancer. 2012 Apr 10 [review date].

74. Expert Commenter 1086. (External, Research/Scientific/Technical). Horizon Scanning Structured Comment Form. HS460 - Trastuzumab-DM1 antibody-drug conjugate for treatment of breast cancer. 2012 Apr 9 [review date].

75. Expert Commenter 395. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS460 - Trastuzumab-DM1 antibody-drug conjugate for treatment of breast cancer. 2012 Apr 10 [review date].

76. Expert Commenter 993. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS460 - Trastuzumab-DM1 antibody-drug conjugate for treatment of breast cancer. 2012 Apr 10 [review date].

77. Expert Commenter 1081. (External, Clinical). Horizon Scanning Structured Comment Form. HS460 - Trastuzumab-DM1 antibody-drug conjugate for treatment of breast cancer. 2012 Apr 18 [review date].

78. Expert Commenter 433. (PRI, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS460 - Trastuzumab-DM1 antibody-drug conjugate for treatment of breast cancer. 2012 Apr 18 [review date].

79. Expert Commenter 1066. (External, Clinical). Horizon Scanning Structured Comment Form. HS1193 - Her2 dimerization inhibitor (pertuzumab) for treatment of metastatic breast cancer. 2011 Oct 22 [review date].

80. Expert Commenter 419. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS1193 - Her2 dimerization inhibitor (pertuzumab) for treatment of metastatic breast cancer. 2011 Oct 24 [review date].

81. Expert Commenter 441. (PRI, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS1193 - Her2 dimerization inhibitor (pertuzumab) for treatment of metastatic breast cancer. 2011 Oct 24 [review date].

82. Expert Commenter 403. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS1193 - Her2 dimerization inhibitor (pertuzumab) for treatment of metastatic breast cancer. 2011 Oct 17 [review date].

83. Expert Commenter 1073. (External, Clinical). Horizon Scanning Structured Comment Form. HS1193 - Her2 dimerization inhibitor (pertuzumab) for treatment of metastatic breast cancer. 2011 Oct 25 [review date].

84. Expert Commenter 681. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS1193 - Her2 dimerization inhibitor (pertuzumab) for treatment of metastatic breast cancer. 2011 Oct 26 [review date].

85. Expert Commenter 400. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS1193 - Her2 dimerization inhibitor (pertuzumab) for treatment of metastatic breast cancer. 2011 Oct 21 [review date].

86. Ned RM, Melillo S, Marrone M. Fecal DNA testing for colorectal cancer screening: the ColoSure test. PLoS Genet 2011;3:RRN1220. PMID: 21487548

87. Screen for life: national colorectal cancer action campaign. [internet]. Atlanta (GA): Centers for Disease Control and Prevention (CDC); 2011 [accessed 2011 Sep 26]. [5 p]. Available: http://www.cdc.gov/cancer/colorectal/sfl/.

88. Potter MB, Phengrasamy L, Hudes ES, et al. Offering annual fecal occult blood tests at annual flu shot clinics increases colorectal cancer screening rates. Ann Fam Med 2009 Jan-Feb;7(1):17-23. PMID: 19139445

89. Klabunde CN, Vernon SW, Nadel MR, et al. Barriers to colorectal cancer screening: a comparison of reports from primary care physicians and average-risk adults. Med Care 2005 Sep;43(9):939-44. PMID: 16116360

90. Guerra CE, Schwartz JS, Armstrong K, et al. Barriers of and facilitators to physician recommendation of colorectal cancer screening. J Gen Intern Med 2007 Dec;22(12):1681-8. PMID: 17939007

91. Potter MB, Somkin CP, Ackerson LM, et al. The FLU-FIT program: an effective colorectal cancer screening program for high volume flu shot

clinics. Am J Manag Care 2011;17(8):577-83. PMID: 21851145

92. Potter MB, Gildengorin G, Wang Y, et al. Comparative effectiveness of two pharmacy-based colorectal cancer screening interventions during an annual influenza vaccination campaign. J Am Pharm Assoc 2010 Mar-Apr 1;50(2):181-7. PMID: 20199960

93. Potter MB, Walsh JM, Yu TM, et al. The effectiveness of the FLU-FOBT program in primary care a randomized trial. Am J Prev Med 2011 Jul;41(1):9-16. PMID: 21665058

94. Potter MB, Yu TM, Gildengorin G, et al. Adaptation of the FLU-FOBT program for a primary care clinic serving a low-income Chinese American community: new evidence of effectiveness. J Health Care Poor Underserved 2011;22(1):284-95. PMID: 21317522

95. Slomski A. Expert panel offers advice to improve screening rates for colorectal cancer. JAMA 2010 Apr 14;303(14):1356-7.

96. ECRI Institute. Colorectal cancer. Plymouth Meeting (PA): ECRI Institute; 2009 Aug 13. 2 p. (Health Technology Forecast).

97. Expert Commenter 428. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS1085 - Concomitant colorectal cancer screening and annual influenza vaccination (FLU-FOBT) program. 2011 Oct 24 [review date].

98. Expert Commenter 405. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS1085 - Concomitant colorectal cancer screening and annual influenza vaccination (FLU-FOBT) program. 2011 Oct 24 [review date].

99. Expert Commenter 993. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS1085 - Concomitant colorectal cancer screening and annual influenza vaccination (FLU-FOBT) program. 2011 Oct 25 [review date].

100. Expert Commenter 400. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS1085 - Concomitant colorectal cancer screening and annual influenza vaccination (FLU-FOBT) program. 2011 Oct 19 [review date].

101. Expert Commenter 442. (PRI, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS1085 - Concomitant colorectal cancer screening and annual influenza vaccination (FLU-FOBT) program. 2011 Oct 18 [review date].

102. Expert Commenter 610. (External, Clinical). Horizon Scanning Structured Comment Form. HS1085 - Concomitant colorectal cancer screening and annual influenza vaccination (FLU-FOBT) program. 2011 Oct 20 [review date].

103. Expert Commenter 172. (External, Clinical). Horizon Scanning Structured Comment Form. HS1085 - Concomitant colorectal cancer screening and annual influenza vaccination (FLU-FOBT) program. 2011 Oct 25 [review date].

104. Lofton-Day C, Model F, Devos T, et al. DNA methylation biomarkers for blood-based colorectal cancer screening. Clin Chem 2008 Feb;54(2):414-23. PMID: 18089654

105. Epi proColon. [internet]. Berlin (Germany): Epigenomics AG; [accessed 2010 Dec 6]. [1 p]. Available: http://www.epigenomics.com/en/products-services/epi-procolon.html.

106. Epigenomics AG completes U.S. clinical validation study for colorectal cancer blood test Epi proColon; provides update on U.S. regulatory plans. [internet]. Berlin (Germany): Epigenomics AG; 2011 Dec 9 [accessed 2012 Feb 8]. [1 p]. Available: http://www.epigenomics.com/en/news-investors/news-media/press-releases/2011.html.

107. Epigenomics AG: corporate presentation [slide set]. Berlin (Germany): Epigenomics AG; 2012 Jan. 27 p. Also available: http://www.epigenomics.com/fileadmin/site_files/01_epigenomics_ag/04_news_investors/02_news_and_media/01_praesentationen/120109_Epigenomics_AG_JPM_corp_presentation.pdf.

108. Epigenomics announces initiation of PMA filing for Epi proColon, provides update on regulatory timeline. [internet]. Berlin (Germany): Epigenomics AG; 2012 Jan 4 [accessed 2012 Feb 8]. [2 p]. Available: http://www.epigenomics.com/en/news-investors/news-media/press-releases/article/epigenomics-kuendigt-den-beginn-der-pma-einreichung-fuer-epi-procolonR-an-und-gibt-ein-update-zum-regu.html.

109. Epigenomics AG enrolls first participant in its FIT comparative study with Epi proColon. [internet]. Berlin (Germany): Epigenomics AG; 2012 Apr 11 [accessed 2012 May 17]. [2 p]. Available:

http://www.epigenomics.com/en/news-investors/news-media/press-releases/article/epigenomics-ag-schliesst-ersten-patienten-in-seine-fit-vergleichsstudie-mit-epi-procolonR-ein.html.

110. ARUP Laboratories to offer new blood-based colorectal cancer screening test. [internet]. Atlanta (GA): Lab Business Week; 2010 Aug 8 [accessed 2010 Dec 6]. [2 p]. Available: http://www.newsrx.com.

111. Expert Commenter 410. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS658 - Methylated Septin 9 plasma DNA test for colorectal cancer screening. 2012 Apr 10 [review date].

112. Expert Commenter 419. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS658 - Methylated Septin 9 plasma DNA test for colorectal cancer screening. 2012 Apr 10 [review date].

113. Expert Commenter 724. (External, Clinical). Horizon Scanning Structured Comment Form. HS658 - Methylated Septin 9 plasma DNA test for colorectal cancer screening. 2012 Apr 18 [review date].

114. Expert Commenter 394. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS658 - Methylated Septin 9 plasma DNA test for colorectal cancer screening. 2012 Apr 10 [review date].

115. Expert Commenter 447. (PRI, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS658 - Methylated Septin 9 plasma DNA test for colorectal cancer screening. 2012 Apr 26 [review date].

116. Expert Commenter 993. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS658 - Methylated Septin 9 plasma DNA test for colorectal cancer screening. 2012 Apr 10 [review date].

117. Expert Commenter 610. (External, Clinical). Horizon Scanning Structured Comment Form. HS658 - Methylated Septin 9 plasma DNA test for colorectal cancer screening. 2012 Apr 5 [review date].

118. FDA approves the NovoTTF-100A system for the treatment of patients with recurrent glioblastoma multiforme (GBM) brain tumors. [internet]. Portsmouth (NH): Novocure Ltd.; 2011 Apr 15 [accessed 2011 May 16]. [2 p]. Available: http://www.eurekalert.org/pub_releases/2011-04/epr-fat041411.php.

119. Salzberg M, Kirson E, Palti Y, et al. A pilot study with very low-intensity, intermediate-frequency electric fields in patients with locally advanced and/or metastatic solid tumors. Onkologie 2008 Jul;31(7):362-5. PMID: 18596382

120. Pivotal (phase III) clinical trial for newly diagnosed GBM glioblastoma multiforme brain tumors. [internet]. Portsmouth (NH): Novocure Ltd.; [accessed 2010 Sep 26]. [12 p]. Available: http://www.novocure.com/clinical_trials.php?ID=1.

121. Stupp R, Kanner A, Engelhard H, et al. A prospective, randomized, open-label, phase III clinical trial of NovoTTF-100A versus best standard of care chemotherapy in patients with recurrent glioblastoma. J Clin Oncol 2010 Jun 20;28(18 Suppl 1):LBA2007. Also available: http://meeting.ascopubs.org/cgi/content/abstract/28/18_suppl/LBA2007?sid=b6a2923a-eb1b-4ff7-aace-ded76cc81d56.

122. Novocure establishes initial clinical centers of excellence for treatment of recurrent glioblastoma multiforme with tumor treating fields (TTFields) therapy. [internet]. Portsmouth (NH): Novocure; 2011 Dec 2 [accessed 2012 Mar 2]. [3 p]. Available: http://www.novocure.com/files/files/2011-12-02-Launch-Release.pdf.

123. Aetna, Inc. Clinical policy bulletin: electric tumor treatment fields. Number: 0827. [internet]. Hartford (CT): Aetna, Inc.; 2012 Mar 16 [accessed 2012 Mar 25]. [5 p]. Available: http://www.aetna.com/cpb/medical/data/800_899/0827.html.

124. Anthem Insurance Companies. Medical policy DME.00035: electric tumor treatment field (TTF). [internet]. Indianapolis (IN): Anthem Insurance Companies; 2012 Jan 11 [accessed 2012 Mar 2]. [5 p]. Available: http://www.anthem.com/ca/medicalpolicies/policies/mp_pw_c141847.htm.

125. Novocure. Effect of NovoTTF-100A together with temozolomide in newly diagnosed glioblastoma multiforme (GBM). In: Clinicaltrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2010 Nov 29]. [4 p]. Available: http://www.clinicaltrials.gov/ct2/show/NCT00916409 NLM Identifier: NCT00916409.

126. Pless M, Betticher DC, Buess M, et al. A phase II study of tumor treating fields (TTfields) in combination with pemetrexed for advanced non-small cell lung cancer (NSCLC). Ann Oncol

2010 Oct;21(Suppl 8):viii125. Also available: http://annonc.oxfordjournals.org.

127. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology: central nervous system cancers. V 1.2011 [slide set]. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2010 Oct 13. 90 p. Also available: http://www.nccn.org/professionals/physician_gls/pdf/cns.pdf.

128. Expert Commenter 394. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS131 - Tumor treating fields therapy for brain cancer. 2011 Jan 31 [review date].

129. Expert Commenter 413. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS131 - Tumor treating fields therapy for brain cancer. 2011 Jan 22 [review date].

130. Expert Commenter 422. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS131 - Tumor treating fields therapy for brain cancer. 2011 Jan 24 [review date].

131. Expert Commenter 448. (External, Clinical). Horizon Scanning Structured Comment Form. HS131 - Tumor treating fields therapy for brain cancer. 2011 Mar 16 [review date].

132. Expert Commenter 653. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS131 - Tumor treating fields therapy for brain cancer. 2011 Apr 25 [review date].

133. Expert Commenter 718. (External, Research). Horizon Scanning Structured Comment Form. HS131 - Tumor treating fields therapy for brain cancer. 2011 Jun 3 [review date].

134. Expert Commenter 725. (External, Clinical). Horizon Scanning Structured Comment Form. HS131 - Tumor treating fields therapy for brain cancer. 2011 May 19 [review date].

135. Thomson Pharma Partnering Forecast [database online]. Thomson Reuters; [accessed 2010 Dec 14]. Brentuximab vedotin. [12 p]. Available: https://forecast.thomson-pharma.com.

136. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology: Hodgkin lymphoma. V. 2.2010 [slide set]. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2010 Jul 28. 52 p. Also available: http://www.nccn.org/professionals/physician_gls/pdf/hodgkins.pdf.

137. Seattle Genetics, Inc. Brentuximab vedotin (SGN-35) ODAC briefing document summary. Bothell (WA): Seattle Genetics, Inc.; 2011 Jun 6. 64 p.

138. Brentuximab vedotin (SGN-35): product pipeline. [internet]. Bothell (WA): Seattle Genetics, Inc.; [accessed 2011 Jul 9]. [2 p]. Available: http://www.seagen.com/product_pipeline_sgn35.shtml.

139. Younes A, Gopal AK, Smith SE, et al. Results of a pivotal phase II study of brentuximab vedotin for patients with relapsed or refractory Hodgkin's lymphoma. J Clin Oncol 2012 Mar 26. [Epub ahead of print]. PMID: 22454421

140. ADCETRIS (brentuximab vedotin) for injection. Bothell (WA): Seattle Genetics, Inc.; 2011 Aug. 15 p. Also available: http://www.adcetris.com/_pdf/Adcetris_USPI_2011.pdf.

141. Younes A, Bartlett NL, Leonard JP, et al. Brentuximab vedotin (SGN-35) for relapsed CD30-positive lymphomas. N Engl J Med 2010 Nov 4;363(19):1812-21. PMID: 21047225

142. Seattle Genetics and Millennium report positive data from pivotal trial of brentuximab vedotin (SGN-35) in relapsed or refractory Hodgkin lymphoma at ASH Annual Meeting. [internet]. Bothell (WA): Seattle Genetics, Inc.; 2010 [accessed 2011 Feb 23]. [2 p]. Available: http://investor.seagen.com/phoenix.zhtml?c=124860&p=irol-newsArticle&ID=1504306&highlight.

143. FDA drug safety communication: new boxed warning and contraindication for Adcetris (brentuximab vedotin). [internet]. Silver Spring (MD): U.S. Food and Drug Administration (FDA); 2012 Jan 13 [accessed 2012 Jan 18]. [3 p]. Available: http://www.fda.gov/Drugs/DrugSafety/ucm287668.htm.

144. Pro B, Advani R, Brice P, et al. Durable remissions with brentuximab vedotin (SGN-35): updated results of a phase II study in patients with relapsed or refractory systemic anaplastic large cell lymphoma (sALCL). J Clin Oncol 2011;29(suppl):abstr 8032.

145. Seattle Genetics announces FDA accelerated approval of Adcetris (brentuximab vedotin) for two indications. [internet]. Bothell (WA): Seattle Genetics, Inc.; 2011 Aug 19 [accessed 2011 Aug

22]. [3 p]. Available: http://investor.seagen.com/phoenix.zhtml?c=124860&p=irol-newsArticle&ID=1598466&highlight.

146. Seattle Genetics announces FDA accepts brentuximab vedotin BLAs for filing and grants priority review for relapsed or refractory Hodgkin lymphoma and systemic ALCL. [internet]. Bothell (WA): Seattle Genetics, Inc.; 2011 May 2 [accessed 2011 May 13]. [2 p]. Available: http://phx.corporate-ir.net/preview/phoenix.zhtml?c=124860&p=irol-newsArticle&ID=1557621&highlight=?id.

147. Seattle Genetics. A phase 1 study of brentuximab vedotin combined with multi-agent chemotherapy for Hodgkin lymphoma. In: ClinicalTrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2011 Jul 9]. [4 p]. Available: http://www.clinicaltrials.gov/ct2/show/NCT01060904 NLM Identifier: NCT01060904.

148. Seattle Genetics, Inc. A phase 1 study of brentuximab vedotin given sequentially and combined with multi-agent chemotherapy for anaplastic large cell lymphoma. In: ClinicalTrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2011 Jul 9]. [5 p]. Available: http://clinicaltrials.gov/ct2/show/NCT01309789 NLM Identifier: NCT01309789.

149. Adcetris pricing. [internet]. Port Washington (NY): RxUSA Inc.; [accessed 2011 Nov 4]. [1 p]. Available: http://rxusa.com/cgi-bin2/shop/cart.cgi?test_cookie=yes&action=add&test_cookie=&passthecartfile=&id=51144005001&qty=1&name=ADCETRIS+50MG+SINGLE+USE+VIAL+LYOPH+POWDER-CHECK+P&desc=1.00+VIAL&price=5875.00.

150. Seattle Genetics sets Adcetris price. [internet]. Bothell (WA): Seattle Genetics, Inc.; 2011 Aug 22 [accessed 2011 Nov 4]. [3 p]. Available: http://www.bioportfolio.com/news/article/777951/Seattle-Genetics-Sets-Adcetris-Price.html.

151. Aetna, Inc. Clinical policy bulletin: brentuximab (Adcetris). Number: 0823. [internet]. Hartford (CT): Aetna, Inc.; 2011 Dec 16 [accessed 2012 Jan 13]. [4 p]. Available: http://www.aetna.com/cpb/medical/data/800_899/0823.html.

152. Anthem Insurance Companies, Inc. Brentuximab vedotin (Adcetris) [Policy #: DRUG.00047]. [internet]. North Haven (CT): Anthem Insurance Companies, Inc.; 2012 Jan 1 [accessed 2012 Jan 13]. [5 p]. Available: http://www.anthem.com/medicalpolicies/policies/mp_pw_c145621.htm.

153. Blue Cross and Blue Shield of Alabama. Adcetris (brentuximab vedotin). Policy no. 481. [internet]. East Birmingham (AL): Blue Cross and Blue Shield of Alabama; 2011 Sep [accessed 2012 Jan 13]. [5 p]. Available: http://www.bcbsal.com.

154. HealthPartners. Brentuximab vedotin (Adcetris). Policy Number B004-01. Minneapolis (MN): HealthPartners; 2012 Jan 1. 2 p. Also available: http://www.healthpartners.com.

155. Humana, Inc. Adcetris (brentuximab vedotin). Louisville (KY): Humana, Inc.; 2011 Sep 1. 7 p. Also available: http://www.humana.com.

156. Regence Group. Adcetris, brentuximab. Policy no. dru264. [internet]. Portland (OR): Regence Group; 2011 Nov 11 [accessed 2012 Jan 18]. [6 p]. Available: http://www.regence.com.

157. Patient assistance application/benefit investigation form. [internet]. Bothell (WA): Seattle Genetics, Inc.; [accessed 2012 Jan 18]. [2 p]. Available: http://www.seagensecure.com/_pdf/ss_form_en_0829.pdf.

158. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology: non-Hodgkin's lymphomas. Version 1.2011 [slide set]. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2010 Nov 29. 184 p. Also available: http://www.nccn.org/professionals/physician_gls/pdf/nhl.pdf.

159. Expert Commenter 410. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS616 - Brentuximab vedotin (Adcetris) for recurrent or treatment-refractory Hodgkin lymphoma. 2012 Mar 15 [review date].

160. Expert Commenter 419. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS616 - Brentuximab vedotin (Adcetris) for recurrent or treatment-refractory Hodgkin lymphoma. 2012 Mar 15 [review date].

161. Expert Commenter 663. (External, Clinical). Horizon Scanning Structured Comment Form. HS616 - Brentuximab vedotin (Adcetris) for recurrent or treatment-refractory Hodgkin lymphoma. 2012 Feb 28 [review date].

162. Expert Commenter 728. (External, Clinical). Horizon Scanning Structured Comment Form. HS616 - Brentuximab vedotin (Adcetris) for

recurrent or treatment-refractory Hodgkin lymphoma. 2012 Mar 1 [review date].

163. Expert Commenter 397. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS616 - Brentuximab vedotin (Adcetris) for recurrent or treatment-refractory Hodgkin lymphoma. 2012 Mar 15 [review date].

164. Expert Commenter 938. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS616 - Brentuximab vedotin (Adcetris) for recurrent or treatment-refractory Hodgkin lymphoma. 2012 Apr 23 [review date].

165. Expert Commenter 396. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS617 - Brentuximab vedotin (Adcetris) for the treatment of recurrent/refractory anaplastic large cell lymphoma. 2012 Mar 15 [review date].

166. Expert Commenter 410. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS617 - Brentuximab vedotin (Adcetris) for the treatment of recurrent/refractory anaplastic large cell lymphoma. 2012 Mar 15 [review date].

167. Expert Commenter 419. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS617 - Brentuximab vedotin (Adcetris) for the treatment of recurrent/refractory anaplastic large cell lymphoma. 2012 Mar 15 [review date].

168. Expert Commenter 663. (External, Clinical). Horizon Scanning Structured Comment Form. HS617 - Brentuximab vedotin (Adcetris) for the treatment of recurrent/refractory anaplastic large cell lymphoma. 2012 Feb 22 [review date].

169. Expert Commenter 533. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS617 - Brentuximab vedotin (Adcetris) for the treatment of recurrent/refractory anaplastic large cell lymphoma. 2012 Feb 28 [review date].

170. Expert Commenter 1181. (PRI, Research/Scientific/Technical). Horizon Scanning Structured Comment Form. HS617 - Brentuximab vedotin (Adcetris) for the treatment of recurrent/refractory anaplastic large cell lymphoma. 2012 Apr 23 [review date].

171. National Cancer Institute (NCI). Chronic myeloproliferative disorders treatment (PDQ): health professional version. [internet]. Bethesda (MD): National Institutes of Health (NIH); 2010 Mar 5 [accessed 2010 Dec 20]. [21 p].

172. Advani A, Theil K. Chronic myeloproliferative disorders. [internet]. Cleveland (OH): Cleveland Clinic Center for Continuing Education; [accessed 2010 Dec 22]. [10 p]. Available: http://www.clevelandclinicmeded.com/medicalpubs/diseasemanagement/hematology-oncology/chronic-myeloproliferative-disorders/.

173. Levine RL, Gilliland DG. Myeloproliferative disorders. Blood 2008 Sep 15;112(6):2190-8. PMID: 18779404

174. Tefferi A, Litzow MR, Pardanani A. Long-term outcome of treatment with ruxolitinib in myelofibrosis. N Engl J Med 2011 Oct 13;365(15):1455-7. PMID: 21995409

175. Campas-Moya C. Ruxolitinib. Drugs Future 2010;35(6):457-65.

176. Thomson Reuters Pharma [database online]. Thomson Reuters; [accessed 2010 Dec 21]. Ruxolitinib (oral, myeloproliferative disorders). [56 p]. Available: https://www.thomson-pharma.com.

177. Verstovsek S, Mesa RA, Gotlib J, et al. A double-blind, placebo-controlled trial of ruxolitinib for myelofibrosis. N Engl J Med 2012 Mar 1;366(9):799-807. PMID: 22375971

178. Harrison C, Kiladjian JJ, Al-Ali HK, et al. JAK inhibition with ruxolitinib versus best available therapy for myelofibrosis. N Engl J Med 2012 Mar 1;366(9):787-98. PMID: 22375970

179. JAKAFI (ruxolitinib) tablets, for oral use. [internet]. Wilmington (DE): Incyte Corporation; 2011 Nov [accessed 2012 May 21]. [22 p]. Available: http://www.incyte.com/products/uspi_jakafi.pdf.

180. FDA approves first drug to treat a rare bone marrow disease. [internet]. Silver Spring (MD): U.S. Food and Drug Administration (FDA); 2011 Nov 16 [accessed 2012 May 21]. [2 p]. Available: http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm280102.htm.

181. FDA approves Incytes' Jakafi, first drug to treat MF; advisory panel backs Pfizer's Prevnar 13 for adults. [internet]. London (UK): The Pharma Letter; 2011 Nov 17 [accessed 2012 May 21]. Available: http://www.thepharmaletter.com/file/108919/fda-approves-incytes-jakafi-first-drug-to-treat-mf-advisory-panel-backs-pfizers-prevnar-13-for-adults.html.

182. FDA accepts NDA filing for ruxolitinib as a treatment for myelofibrosis. [internet]. Wilmington (DE): Incyte Corporation; 2011 Aug

3 [accessed 2011 Aug 16]. [2 p]. Available: http://investor.incyte.com/phoenix.zhtml?c=69764&p=irol-newsArticle&ID=1592347&highlight.

183. Mayo Clinic staff. Myelofibrosis. [internet]. Rochester (MN): Mayo Foundation for Medical Education and Research (MFMER); 2009 Feb 3 [accessed 2010 Dec 20]. [7 p]. Available: http://www.mayoclinic.com/health/myelofibrosis/DS00886/METHOD=print&DSECTION=all.

184. Expert Commenter 205. (External, Clinical). Horizon Scanning Structured Comment Form. HS472 - INCB018424 JAK1 and JAK2 inhibitor for treatment of myelofibrosis. 2011 Apr 19 [review date].

185. Expert Commenter 394. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS472 - INCB018424 JAK1 and JAK2 inhibitor for treatment of myelofibrosis. 2011 Jan 25 [review date].

186. Expert Commenter 405. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS472 - INCB018424 JAK1 and JAK2 inhibitor for treatment of myelofibrosis. 2011 Jan 21 [review date].

187. Expert Commenter 414. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS472 - INCB018424 JAK1 and JAK2 inhibitor for treatment of myelofibrosis. 2011 Jan 19 [review date].

188. Expert Commenter 535. (ECRI Institute, SELECT Group). Horizon Scanning Structured Comment Form. HS472 - INCB018424 JAK1 and JAK2 inhibitor for treatment of myelofibrosis. 2011 Mar 22 [review date].

189. Expert Commenter 644. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS472 - INCB018424 JAK1 and JAK2 inhibitor for treatment of myelofibrosis. 2011 Jun 22 [review date].

190. Expert Commenter 686. (External, Clinical). Horizon Scanning Structured Comment Form. HS472 - INCB018424 JAK1 and JAK2 inhibitor for treatment of myelofibrosis. 2011 May 24 [review date].

191. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology: non-small cell lung cancer V1.2011 [slide set]. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2010 Nov 18. 94 p. Also available: http://www.nccn.org/professionals/physician_gls/pdf/nscl.pdf.

192. Kwak EL, Bang YJ, Camidge DR, et al. Anaplastic lymphoma kinase inhibition in non-small-cell lung cancer. N Engl J Med 2010 Oct 28;363(18):1693-703. PMID: 20979469

193. Crizotinib: a novel and first-in-class multitargeted tyrosine kinase inhibitor for the treatment of anaplastic lymphoma kinase rearranged non-small cell lung cancer and beyond. Drug Des Devel Ther 2011;5:471-85. Also available: http://www.dovepress.com/crizotinib-a-novel-and-first-in-class-multitargeted-tyrosine-kinase-in-peer-reviewed-article-DDDT.

194. Pfizer. An investigational drug, PF-02341066 is being studied versus standard of care in patients with advanced non-small cell lung cancer with a specific gene profile involving the anaplastic lymphoma kinase (ALK) gene. In: ClinicalTrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2010 Dec 30]. [4 p]. Available: http://www.clinicaltrials.gov/ct2/show/NCT00932893 NLM Identifier: NCT00932893.

195. Pfizer. A clinical trial testing the efficacy of crizotinib versus standard chemotherapy pemetrexed plus cisplatin or carboplatin in patients with ALK positive non-squamous cancer of the lung (PROFILE 1014). In: ClinicalTrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2010 Dec 30]. [4 p]. Available: http://www.clinicaltrials.gov/ct2/show/NCT01154140 NLM Identifier: NCT01154140.

196. XALKORI (crizotinib) capsules, oral prescribing information. [internet]. New York (NY): Pfizer, Inc.; 2012 Feb [accessed 2012 Mar 30]. [18 p]. Available: http://labeling.pfizer.com/showlabeling.aspx?id=676.

197. FDA approval of xalkori (crizotinib) and invitation to media briefing from Pfizer. [internet]. New York (NY): Pfizer Inc.; 2011 Aug 29 [accessed 2011 Sep 1]. [2 p]. Available: http://www.pfizer.com/news/press_releases/pfizer_press_release_archive.jsp#guid=20110829005751en&source=RSS_2011&page=1.

198. Hayes E. Pfizer's Xalkori joins the six-figure oncology drug club. Pink Sheet 2011 Sep 5;73(36):22-4. Also available: www.elsevier.com.

199. Abbott Molecular 2012 U.S. price list. [internet]. Des Plaines (IL): Abbott Molecular; 2012 [accessed 2012 May 17]. [24 p]. Available: https://www.abbottmolecular.com/static/cms_workspace/pdfs/US/us-pl-2012-proof-at-1-27.pdf.

200. Aetna, Inc. Pharmacy clinical policy bulletins: Aetna non-medicare prescription drug plan. Subject: antineoplastics. [internet]. Hartford (CT): Aetna, Inc.; 2012 Feb 24 [accessed 2012 Feb 20]. [10 p]. Available: http://www.aetna.com/products/rxnonmedicare/data/2012/ANEOPL2012/Antineoplastics_2012.html.

201. Anthem Insurance Companies, Inc. Xalkori (crizotinib) clinical criteria. [internet]. Woodland Hills (CA): Anthem Insurance Companies, Inc.; 2011 Nov 29 [accessed 2012 Jan 26]. [2 p]. Available: www.anthem.com.

202. Blue Cross and Blue Shield of Alabama. Drug coverage guidelines. [internet]. East Birmingham (AL): Blue Cross and Blue Shield of Alabama; [accessed 2012 Jan 13]. [14 p]. Available: https://www.bcbsal.org/pharmacy/guidelines.cfm.

203. CIGNA Corporation. Drug list search results: Xalkori. [internet]. Bloomfield (CT): CIGNA Corporation; [accessed 2012 Jan 26]. [2 p]. Available: https://cigna.com.

204. HealthPartners. Specialty medications list. Minneapolis (MN): HealthPartners; 2012 Jan 1. 1 p. Also available: http://www.healthpartners.com.

205. Humana, Inc. Humana medical coverage policy: Xalkori (crizotinib). [internet]. Louisville (KY): Humana, Inc.; 2011 Sep 8 [accessed 2012 Jan 26]. [6 p]. Available: http://apps.humana.com/tad/tad_new/home.aspx.

206. Medica. Medica utilization management policy. Crizotinib (Xalkori). [internet]. Minnetonka (MN): Medica; 2011 Dec 15 [accessed 2012 Jan 26]. [2 p]. Available: www.medica.com.

207. RegenceRx. Medication policy manual: Xalkori, crizotinib. Policy no: dru265. Portland (OR): RegenceRx; 2011 Nov 11. 5 p. Also available: http://blue.regence.com/trgmedpol/drugs/dru265.pdf.

208. Wellmark, Inc. Benefits enrollment guide [BlueAccess and BlueRx Preferred]. Des Moines (IA): Wellmark, Inc.; 2011 Nov 1. 84 p. Also available: wellmark.com.

209. National Comprehensive Cancer Network (NCCN). Non-small cell lung cancer. Version 2010 [NCCN guidelines for patients]. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2010. 72 p. Also available: http://www.nccn.com/images/patient-guidelines/pdf/nsclc.pdf.

210. Thomson Reuters Pharma [database online]. Thomson Reuters; [accessed 2010 Dec 30]. Crizotinib. [26 p]. Available: https://www.thomson-pharma.com.

211. Expert Commenter 401. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS230 - Crizotinib ALK inhibitor for treatment of lung cancer-containing ALK rearrangements. 2012 Apr 26 [review date].

212. Expert Commenter 1175. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS230 - Crizotinib ALK inhibitor for treatment of lung cancer-containing ALK rearrangements. 2012 Apr 16 [review date].

213. Expert Commenter 1076. (External, Clinical). Horizon Scanning Structured Comment Form. HS230 - Crizotinib ALK inhibitor for treatment of lung cancer-containing ALK rearrangements. 2012 Apr 24 [review date].

214. Expert Commenter 727. (External, Clinical). Horizon Scanning Structured Comment Form. HS230 - Crizotinib ALK inhibitor for treatment of lung cancer-containing ALK rearrangements. 2012 Apr 18 [review date].

215. Expert Commenter 533. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS230 - Crizotinib ALK inhibitor for treatment of lung cancer-containing ALK rearrangements. 2012 Apr 25 [review date].

216. Expert Commenter 993. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS230 - Crizotinib ALK inhibitor for treatment of lung cancer-containing ALK rearrangements. 2012 Apr 19 [review date].

217. Expert Commenter 695. (External, Clinical). Horizon Scanning Structured Comment Form. HS230 - Crizotinib ALK inhibitor for treatment of lung cancer-containing ALK rearrangements. 2012 Apr 18 [review date].

218. Expert Commenter 422. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS230 - Crizotinib ALK inhibitor for treatment of lung cancer-containing ALK rearrangements. 2012 Apr 19 [review date].

219. Sartor AO. Progression of metastatic castrate-resistant prostate cancer: impact of therapeutic

intervention in the post-docetaxel space. J Hematol Oncol 2011 Apr 23;4(18):1-27. PMID: 21513551

220. Zytiga (abiraterone acetate) receives FDA approval for treatment of metastatic prostate cancer after priority review. [internet]. Horsham (PA): Centocor Ortho Biotech, Inc.; 2011 Apr 28 [accessed 2011 May 16]. [5 p]. Available: http://www.jnj.com/connect/news/all/zytiga-abiraterone-acetate-receives-fda-approval-for-treatment-of-metastatic-prostate-cancer-after-priority-review.

221. Study unblinded: ZYTIGA (abiraterone acetate) plus prednisone for asymptomatic or mildly symptomatic chemotherapy-naïve patients with metastatic castration-resistant prostate cancer. [internet]. Raritan (NJ): Janssen Research & Development, LLC; 2012 Mar 8 [accessed 2012 Mar 8]. [3 p]. Available: http://www.jnj.com/connect/news/all/study-unblinded-zytiga-abiraterone-acetate-plus-prednisone-for-asymptomatic-or-mildly-symptomatic-chemotherapy-naive-patients-with-metastatic-castration-resistant-prostate-cancer.

222. J&J's prostate drug Zytiga gets final nod in Europe. In: FiercePharma.com [internet]. Washington (DC): FierceMarkets; 2011 Sep 7 [accessed 2012 Feb 8]. [2 p]. Available: http://www.fiercepharma.com/story/jjs-prostate-drug-zytiga-gets-final-nod-europe/2011-09-07.

223. CIGNA Corporation. CIGNA pharmacy coverage policy: abiraterone (Zytiga). Bloomfield (CT): CIGNA Corporation; 2011 Oct 15. 27 p. Also available: http://www.cigna.com/assets/docs/health-care-professionals/coverage_positions/ph_1115_coveragepositioncriteria_zytiga.pdf.

224. CIGNA Corporation. 2012 CIGNA prescription drug list. Bloomfield (CT): CIGNA Corporation; 2012. 24 p. Also available: http://www.cigna.com/.

225. Aetna Medicare. Aetna Medicare 2012 formulary (list of covered drugs). Hartford (CT): Aetna, Inc.; 2012. 106 p. Also available: http://www.aetna.com.

226. Anthem Blue Cross and Blue Shield. 2011 formulary for Blue MedicareRX Premier (PDP). Indianapolis (IN): Anthem Blue Cross and Blue Shield; 2011 Oct. 94 p. Also available: http://www.anthem.com/shop/content/olspublic/pdf/2011/english/Formulary_BluePlus_PDP_WI.pdf.

227. Blue Cross Blue Shield of Alabama. Prior authorization coverage criteria: oral oncology agents - Zytiga (abiraterone). East Birmingham (AL): Blue Cross Blue Shield of Alabama; 2011 Jul. 2 p. Also available: https://www.bcbsal.org/providers/pharmMedicarePolicies/final/4100.pdf.

228. Blue Cross Blue Shield of Massachusetts. Medicare HMO 2012 formulary. Boston (MA): Blue Cross Blue Shield of Massachusetts; 2012 Jan 1. 91 p. Also available: http://www.bluecrossma.com/medicare-options/2012/pdf/55-0182-MedHMO-Formulary.pdf.

229. HealthPartners. 2012 Medicare part D formulary ID12129, version 8 (enhanced). Bloomington (MN): HealthPartners; 8 p. Also available: http://www.healthpartners.com/ucm/groups/public/@hp/@public/documents/documents/cntrb_011159.pdf.

230. Humana, Inc. 2012 prescription drug guide Humana formulary [Humana Complete Region 25]. Louisville (KY): Humana, Inc.; 2012. 208 p. Also available: http://www.humana.com/providers/pharmacy/drug_list.aspx.

231. Medica. Part D 2011 prior authorization descriptions. [internet]. Minnetonka (MN): Medica; 2011 Oct 28 [accessed 2012 Jan 27]. [134 p]. Available: http://provider.medica.com/router/default.pdf?doc=/C7/PharmacyResources/Document%20Library/2011_PartD_Prior_Authorization_Desc.pdf.

232. UnitedHealthcare, Inc. 2012 comprehensive formulary. Edina (MN): UnitedHealthcare, Inc.; 2012 Jan 1. 100 p. Also available: http://www.q1medicare.com/2012/content/includes/pdpPlanMaterials/AARP-2012_PDP_Formulary_Preferred.pdf.

233. Wellmark, Inc. Wellmark specialty drug list. Des Moines (IA): Wellmark, Inc.; 2011 Jul. 2 p. Also available: http://www.wellmark.com/HealthAndWellness/DrugInformation/SpecialPrograms/docs/WellmarkSpecialtyDrugs.pdf.

234. Thomson Reuters Integrity [database online]. Barcelona: Thomson Reuters; [accessed 2011 Apr 24]. Orteronel. [81 p]. Available: https://integrity.prous.com.

235. Thomson Reuters Integrity [database online]. Barcelona: Thomson Reuters; [accessed 2011 Jul 15]. MDV3100. [16 p]. Available: https://integrity.prous.com.

236. Medivation and Astellas announce positive survival data from interim analysis of phase 3

AFFIRM trial of MDV3100 in men with advanced prostate cancer. [internet]. San Francisco (CA): Medivation, Inc; 2011 Nov 3 [accessed 2011 Nov 15]. [3 p].

237. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology: prostate cancer. V.1.2011 [slide set]. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2010 Dec 13. 59 p. Also available: http://www.nccn.org/professionals/physician_gls/PDF/prostate.pdf.

238. Expert Commenter 413. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS227 - Abiraterone for treatment of castration-resistant prostate cancer. 2011 Apr 18 [review date].

239. Expert Commenter 414. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS227 - Abiraterone for treatment of castration-resistant prostate cancer. 2011 Apr 11 [review date].

240. Expert Commenter 427. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS227 - Abiraterone for treatment of castration-resistant prostate cancer. 2011 Apr 18 [review date].

241. Expert Commenter 551. (External, Clinical). Horizon Scanning Structured Comment Form. HS227 - Abiraterone for treatment of castration-resistant prostate cancer. 2011 Apr 6 [review date].

242. Expert Commenter 387. (External, Clinical). Horizon Scanning Structured Comment Form. HS227 - Abiraterone for treatment of castration-resistant prostate cancer. 2011 Apr 28 [review date].

243. Expert Commenter 399. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS227 - Abiraterone for treatment of castration-resistant prostate cancer. 2011 Apr 22 [review date].

244. Expert Commenter 433. (PRI, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS227 - Abiraterone for treatment of castration-resistant prostate cancer. 2011 Jun 14 [review date].

245. Alpharadin. [database online]. Thomson Reuters; [accessed 2011 Jul 20]. [44 p]. Available: https://www.thomson-pharma.com.

246. Roque I Figuls M, Martinez-Zapata MJ, Scott-Brown M, et al. Radioisotopes for metastatic bone pain. Cochrane Database Syst Rev 2011;(7):CD003347. PMID: 21735393

247. Fighting tumors with alpha radiation. Bayer Research 22:10-3.

248. Positive phase III data on Bayer's investigational drug Alpharadin show significant increase in overall survival. [internet]. Berlin (Germany): Bayer HealthCare Pharmaceuticals; 2011 Sep 24 [accessed 2011 Sep 27]. [2 p]. Available: http://www.bayer.com/en/news-detail.aspx?newsid=15028.

249. Algeta ASA. A study of Alpharadin with docetaxel in patients with bone metastasis from castration-resistant prostate cancer (CRPC). In: ClinicalTrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2011 Nov 15]. [5 p]. Available: http://clinicaltrials.gov/ct2/show/NCT01106352 NLM Identifier: NCT01106352.

250. FDA grants fast track designation to Alpharadin for the treatment of castration-resistant prostate cancer patients with bone metastases. [internet]. Oslo (Norway): Algeta ASA; 2011 Aug 23 [accessed 2011 Aug 28]. [2 p]. Available: http://www.algeta.com/xml_press_underside.asp?xml=http://cws.huginonline.com/A/134655/PR/201108/1540232.xml&m=34572&s=34686&ss=&d=2011-08-23.

251. Exelixis to initiate cabozantinib '306 trial with pain endpoint in mCRPC. [internet]. South San Francisco (CA): Exelixis, Inc; 2011 Oct 31 [accessed 2011 Nov 15]. [3 p]. Available: http://ir.exelixis.com/phoenix.zhtml?c=120923&p=irol-newsArticle&ID=1623911&highlight=.

252. Hillegonds DJ, Franklin S, Shelton DK, et al. The management of painful bone metastases with an emphasis on radionuclide therapy. J Natl Med Assoc 2007 Jul;99(7):785-94. PMID: 17668645

253. Expert Commenter 24. (External, Clinical). Horizon Scanning Structured Comment Form. HS1115 - Radium-223 (Alpharadin) for treatment of bone metastases associated with solid tumors. 2012 Apr 23 [review date].

254. Expert Commenter 406. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS1115 - Radium-223 (Alpharadin) for treatment of bone metastases associated with solid tumors. 2012 Apr 10 [review date].

255. Expert Commenter 1014. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS1115 - Radium-

223 (Alpharadin) for treatment of bone metastases associated with solid tumors. 2012 Apr 13 [review date].

256. Expert Commenter 533. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS1115 - Radium-223 (Alpharadin) for treatment of bone metastases associated with solid tumors. 2012 Apr 19 [review date].

257. Expert Commenter 993. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS1115 - Radium-223 (Alpharadin) for treatment of bone metastases associated with solid tumors. 2012 Apr 10 [review date].

258. Expert Commenter 529. (External, Research/Scientific/Technical). Horizon Scanning Structured Comment Form. HS1115 - Radium-223 (Alpharadin) for treatment of bone metastases associated with solid tumors. 2012 Apr 4 [review date].

259. Expert Commenter 422. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS1115 - Radium-223 (Alpharadin) for treatment of bone metastases associated with solid tumors. 2012 Apr 10 [review date].

260. Melanoma fact sheet. [internet]. Schaumburg (IL): American Academy of Dermatology; 2010 [accessed 2010 Dec 29]. [3 p]. Available: http://www.aad.org/media/background/factsheets/fact_melanoma.html.

261. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology: melanoma. V1.2011 [slide set]. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2010 Oct 15. 49 p. Also available: http://www.nccn.org/professionals/physician_gls/pdf/melanoma.pdf.

262. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology: melanoma. V2.2012 [slide set]. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2011 Sep 21. 51 p. Also available: http://www.nccn.org/professionals/physician_gls/pdf/melanoma.pdf.

263. Flaherty KT. Narrative review: BRAF opens the door for therapeutic advances in melanoma. Ann Intern Med 2010 Nov 2;153(9):587-91. PMID: 21041578

264. Smalley KS, Sondak VK. Melanoma--an unlikely poster child for personalized cancer therapy. N Engl J Med 2010 Aug 26;363(9):876-8. PMID: 20818849

265. Chapman PB, Hauschild A, Robert C,et al. Improved survival with vemurafenib in melanoma with BRAF V600E mutation. N Engl J Med 2011 Jun 30;364(26):2507-16. PMID: 21639808

266. Investor update: New drug applications submitted in the United States and Europe for vemurafenib in advanced skin cancer. [internet]. Basel (Switzerland): Roche; 2011 May 11 [accessed 2011 May 18]. [2 p]. Available: http://www.roche.com/investors/ir_update/inv-update-2011-05-11.htm.

267. Vemurafenib. [internet]. Silver Spring (MD): U.S. Food and Drug Administration (FDA); 2011 Aug 17 [accessed 2011 Sep 1]. [2 p]. Available: http://www.fda.gov/AboutFDA/CentersOffices/CDER/ucm268301.htm.

268. FDA approves Zelboraf and companion diagnostic test for late-stage skin cancer. [internet]. Silver Spring (MD): U.S. Food and Drug Administration (FDA); 2011 Aug 17 [accessed 2011 Aug 17]. [2 p]. Available: http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm268241.htm.

269. Rockoff JD. Guided by genes, shrinking cancer. [internet]. New York (NY): Wall Street Journal; 2011 Aug 18 [accessed 2011 Aug 18]. [5 p]. Available: http://online.wsj.com/article/SB10001424053111903639404576514084262209282.html.

270. How do I fill my ZELBORAF prescription? [internet]. South San Francisco (CA): Genentech USA, Inc.; [accessed 2012 Mar 27]. [4 p]. Available: http://www.zelboraf.com/patient/prescription/index.html.

271. Genentech BioOncology co-pay card. [internet]. South San Francisco (CA): Genentech, USA, Inc.; [accessed 2012 Mar 27]. [3 p]. Available: http://www.zelboraf.com/patient/prescription/copay/index.html.

272. Humana, Inc. Zelboraf (vemurafenib). Louisville (KY): Humana, Inc.; 2011 Aug 25. 5 p. Also available: http://www.humana.com.

273. Medica. Vemurafenib (Zelboraf). [internet]. Minnetonka (MN): Medica; 2011 Dec 15 [accessed 2012 Feb 20]. [2 p]. Available: http://www.medica.com.

274. Regence Group. Zelboraf, vemurafenib. Policy no. dru266. [internet]. Portland (OR): Regence Group; 2011 Nov 11 [accessed 2012 Feb 20]. [5 p]. Available: http://www.regence.com.

275. United HealthCare Services, Inc. Vemurafenib (Zelboraf). Edina (MN): United HealthCare Services, Inc.; 2011. 1 p. Also available: https://www.unitedhealthcareonline.com/b2c/CmaAction.do?channelId=016228193392b010VgnVCM100000c520720a____.

276. Anthem Insurance Companies, Inc. BRAF Mutation Analysis [Policy #GENE.00019]. [internet]. North Haven (CT): Anthem Insurance Companies, Inc.; 2011 Nov 17 [accessed 2012 Feb 20]. [7 p]. Available: http://www.anthem.com/medicalpolicies/policies/mp_pw_c135467.htm.

277. Humana, Inc. Pharmacogenomics (pharmacogenetics). Policy number CLPD-0466-027. Louisville (KY): Humana, Inc.; 2012 Jan 26. 45 p. Also available: http://www.humana.com.

278. GlaxoSmithKline. A study comparing GSK2118436 to dacarbazine (DTIC) in previously untreated subjects with BRAF mutation positive advanced (stage III) or metastatic (stage IV) melanoma. In: Clinicaltrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2011 Jan 13]. [4 p]. Available: http://clinicaltrials.gov/ct2/show/NCT01227889 NLM Identifier: NCT01227889.

279. Aplin AE, Kaplan FM, Shao Y. Mechanisms of resistance to RAF inhibitors in melanoma. J Invest Dermatol 2011 Sep;131(9):1817-20. PMID: 21593776

280. Expert Commenter 419. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS5 - Activated BRAF (vemurafenib) for treatment of metastatic melanoma. 2012 Apr 19 [review date].

281. Expert Commenter 1175. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS5 - Activated BRAF (vemurafenib) for treatment of metastatic melanoma. 2012 Apr 19 [review date].

282. Expert Commenter 531. (External, Clinical). Horizon Scanning Structured Comment Form. HS5 - Activated BRAF (vemurafenib) for treatment of metastatic melanoma. 2012 Apr 18 [review date].

283. Expert Commenter 993. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS5 - Activated BRAF (vemurafenib) for treatment of metastatic melanoma. 2012 Apr 19 [review date].

284. Expert Commenter 404. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS5 - Activated BRAF (vemurafenib) for treatment of metastatic melanoma. 2012 Apr 26 [review date].

285. Expert Commenter 623. (External, Clinical). Horizon Scanning Structured Comment Form. HS5 - Activated BRAF (vemurafenib) for treatment of metastatic melanoma. 2012 Apr 18 [review date].

286. Expert Commenter 938. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS5 - Activated BRAF (vemurafenib) for treatment of metastatic melanoma. 2012 Apr 24 [review date].

287. Low JA, de Sauvage FJ. Clinical experience with hedgehog pathway inhibitors. J Clin Oncol 2010 Dec 20;28(36):5321-6. PMID: 21041712

288. FDA approves new treatment for most common type of skin cancer. [internet]. Silver Spring (MD): U.S. Food and Drug Administration (FDA); 2012 Jan 30 [accessed 2012 Jan 30]. [2 p]. Available: http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm289545.htm.

289. Haddley K. Vismodegib. Drugs Future 2010;35(5):379-84.

290. Pivotal study showed Vismodegib helped shrink tumors or heal lesions in people with rare form of advanced skin cancer. [internet]. South San Francisco (CA): Genentech USA, Inc.; 2011 Jun 19 [accessed 2011 Jun 27]. [2 p]. Available: http://www.gene.com/gene/news/press-releases/display.do?method=detail&id=13507.

291. Erivedge (vismodegib) capsule prescribing information. [internet]. South San Francisco (CA): Genentech USA, Inc.; [accessed 2012 Feb 6]. [2 p]. Available: http://www.erivedge.com/hcp/prescribing-information.html.

292. Roche's Erivedge gains FDA approval. In: InPharm.com [internet]. Hoboken (NJ): John Wiley & Sons, Inc.; 2012 Jan 31 [accessed 2012 Feb 6]. [2 p]. Available: http://www.inpharm.com/news/171150/roche-s-erivedge-gains-fda-approval.

293. How to refer patients to Erivedge access solutions. [internet]. South San Francisco (CA): Genentech USA, Inc.; [accessed 2012 Feb 6]. [2 p]. Available:

http://www.genentechaccesssolutions.com/portal/site/AS/menuitem.7ef3b8542d7c63460313edacd79c23a0/?vgnextoid=a10b14ea1f073310VgnVCM100000ab8c2248RCRD&vgnextchannel=b3b6bd4ece183310VgnVCM100000ab8c2248RCRD.

294. Tang JY, Mackay-Wiggan JM, Aszterbaum M, et al. An investigator-initiated, phase II randomized, double-blind, placebo-controlled trial of GDC-0449 for prevention of BCCs in basal cell nevus syndrome (BCNS) patients [presentation abstract LB-1]. In: Proceedings of the 102nd Annual Meeting of the American Association for Cancer Research. 102nd Annual Meeting ; 2011 Apr 2-6; Orlando (FL).

295. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology: basal cell and squamous cell skin cancers. V 2.2011 [slide set]. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2011. 46 p. Also available: http://www.nccn.org/professionals/physician_gls/f_guidelines.asp.

296. Genentech. A study evaluating the efficacy and safety of GDC-0449 in operable basal cell carcinoma (BCC). In: ClinicalTrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2011 Jun 16]. [4 p]. Available: http://clinicaltrials.gov/ct2/show/NCT01201915 NLM Identifier: NCT01201915.

297. Genentech. A study evaluating the efficacy and safety of GDC-0449 (hedgehog pathway inhibitor) in patients with advanced basal cell carcinoma. In: ClinicalTrials.gov [database online]. Bethesda (MD): National Library of Medicine (U.S.); 2000- [accessed 2011 Jun 16]. [4 p]. Available: http://clinicaltrials.gov/ct2/show/NCT00833417 NLM Identifier: NCT00833417.

298. Expert Commenter 1129. (External, Research/Scientific/Technical). Horizon Scanning Structured Comment Form. HS1032 - Vismodegib for treatment of basal cell carcinoma. 2012 Apr 9 [review date].

299. Expert Commenter 394. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS1032 - Vismodegib for treatment of basal cell carcinoma. 2012 Apr 10 [review date].

300. Expert Commenter 894. (External, Clinical). Horizon Scanning Structured Comment Form. HS1032 - Vismodegib for treatment of basal cell carcinoma. 2012 Apr 25 [review date].

301. Expert Commenter 533. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS1032 - Vismodegib for treatment of basal cell carcinoma. 2012 Mar 23 [review date].

302. Expert Commenter 993. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS1032 - Vismodegib for treatment of basal cell carcinoma. 2012 Apr 10 [review date].

303. Expert Commenter 1015. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS1032 - Vismodegib for treatment of basal cell carcinoma. 2012 Apr 10 [review date].

304. Expert Commenter 531. (External, Clinical). Horizon Scanning Structured Comment Form. HS1032 - Vismodegib for treatment of basal cell carcinoma. 2011 Sep 6 [review date].

305. Morse MA. Technology evaluation: ipilimumab, Medarex/Bristol-Myers Squibb. Curr Opin Mol Ther 2005 Dec;7(6):588-97. PMID: 16370382

306. Verschraegen C. The monoclonal antibody to cytotoxic T lymphocyte antigen 4, ipilimumab, in the treatment of melanoma. Cancer Manag Res 2012;4:1-8. PMID: 22346364

307. Hodi FS, O'Day SJ, McDermott DF, et al. Improved survival with ipilimumab in patients with metastatic melanoma. N Engl J Med 2010 Aug 19;363(8):711-23. PMID: 20525992

308. Mulcahy N. FDA approves ipilimumab for advanced melanoma. In: Medscape Medical News [internet]. New York (NY): WebMD, LLC; 2011 Mar 25 [accessed 2011 May 16]. [2 p]. Available: http://www.medscape.com/viewarticle/739604_print.

309. Yervoy (Ipilimumab) prescribing information. [internet]. Princeton (NJ): Bristol-Myers Squibb; [accessed 2011 May 16]. [7 p]. Available: http://packageinserts.bms.com/pi/pi_yervoy.pdf.

310. Robert C, Thomas L, Bondarenko I, et al. Ipilimumab plus dacarbazine for previously untreated metastatic melanoma. N Engl J Med 2011 Jun 30;364(26):2517-26. PMID: 21639810

311. Pollack A. Approval for drug that treats melanoma. [internet]. New York (NY): New York Times; 2011 Mar 25 [accessed 2011 Mar 31]. [4 p]. Available: http://www.nytimes.com/2011/03/26/business/26drug.html?_r=2.

312. Aetna, Inc. Clinical policy bulletin: ipilimumab (Yervoy). Policy number: 0815. [internet]. Hartford (CT): Aetna, Inc.; 2012 Jan 17

[accessed 2012 Feb 23]. [11 p]. Available: http://www.aetna.com/cpb/medical/data/800_899/0815.html.

313. Anthem Insurance Companies, Inc. Melanoma vaccines [policy #MED.00083]. [internet]. North Haven (CT): Anthem Insurance Companies, Inc.; 2012 Jan 11 [accessed 2012 Mar 12]. [5 p]. Available: http://www.anthem.com/medicalpolicies/policies/mp_pw_a050522.htm.

314. Blue Cross and Blue Shield of Alabama. Yervoy (Ipilimumab) Policy #:335. [internet]. East Birmingham (AL): Blue Cross and Blue Shield of Alabama; 2011 May [accessed 2012 Feb 23]. [4 p]. Available: http://www.bcbsal.com.

315. Regence Group. Yervoy, ipilimumab. Policy No. dru238. [internet]. Portland (OR): Regence Group; [accessed 2012 Feb 23]. [6 p]. Available: http://www.regence.com.

316. Wellmark, Inc. Ipilimumab (Yervoy) [Medical Policy: 05.01.34]. [internet]. Des Moines (IA): Wellmark, Inc.; 2011 Apr [accessed 2012 Feb 23]. [2 p].

317. HCPCS level II professional 2012: a resourceful compilation of HCPCS codes. Eden Prairie (MN): Ingenix; 2011. 152 p.

318. Yervoy (ipilimumab) patient assistance program. [internet]. New York (NY): Bristol-Myers Squibb; 2011 [accessed 2011 Oct 10]. [4 p]. Available: http://www.destinationaccess.com/yervoy/patient-assistance.aspx.

319. Pardoll DM. The blockade of immune checkpoints in cancer immunotherapy. Nat Rev Cancer 2012 Apr;12(4):252-64. PMID: 22437870

320. Expert Commenter 419. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS208 - Ipilimumab for treatment of metastatic melanoma. 2012 Apr 19 [review date].

321. Expert Commenter 1175. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS208 - Ipilimumab for treatment of metastatic melanoma. 2012 Apr 19 [review date].

322. Expert Commenter 1011. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS208 - Ipilimumab for treatment of metastatic melanoma. 2012 Apr 25 [review date].

323. Expert Commenter 531. (External, Clinical). Horizon Scanning Structured Comment Form. HS208 - Ipilimumab for treatment of metastatic melanoma. 2012 Apr 23 [review date].

324. Expert Commenter 993. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS208 - Ipilimumab for treatment of metastatic melanoma. 2012 Apr 23 [review date].

325. Expert Commenter 404. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS208 - Ipilimumab for treatment of metastatic melanoma. 2012 Apr 26 [review date].

326. Expert Commenter 623. (External, Clinical). Horizon Scanning Structured Comment Form. HS208 - Ipilimumab for treatment of metastatic melanoma. 2012 Apr 19 [review date].

327. Solomon B, Rischin D. Progress in molecular targeted therapy for thyroid cancer: vandetanib in medullary thyroid cancer. J Clin Oncol 2012 Jan 10;30(2):119-21. Epub 2011 Oct 24. PMID: 22025155

328. Genetics of medullary thyroid cancer (PDQ): natural history of medullary thyroid cancer. [internet]. Bethesda (MD): National Cancer Institute (NCI); [accessed 2011 Jun 15]. [3 p]. Available: http://www.cancer.gov/cancertopics/pdq/genetics/medullarythyroid/HealthProfessional#Section_289.

329. Deshpande H, Roman S, Thumar J, et al. Vandetanib (ZD6474) in the treatment of medullary thyroid cancer. Clin Med Insights Oncol 2011;5:213-21. PMID: 21836817

330. The use of Vandetanib in locally advanced or metastatic medullary thyroid cancer. Evaluation report. Newcastle upon Tyne (UK): Regional Drug and Therapeutics Centre; 2011 Feb. 18 p. Also available: http://www.nyrdtc.nhs.uk/docs/eva/RDTC_VANDETANIB_ER.pdf.

331. Wells SA Jr, Robinson BG, Gagel RF, et al. Vandetanib in patients with locally advanced or metastatic medullary thyroid cancer: a randomized, double-blind phase III trial. J Clin Oncol 2012 Jan 10;30(2):134-41. Epub 2011 Oct 24. PMID: 22025146

332. Caprelsa (vandetanib) tablets - highlights of prescribing information. Wilmington (DE): AstraZeneca Pharmaceuticals LP; 2011 Jun. 8 p. Also available: http://www1.astrazeneca-us.com/pi/vandetanib.pdf.

333. Learn about the CAPRELSA REMS program. [internet]. Wilmington (DE): AstraZeneca Pharmaceuticals LP; 2011 Jul [accessed 2012 Apr 6]. [2 p]. Available: http://www.caprelsarems.com/learn.aspx.

334. Exelixis' cabozantinib meets primary endpoint in phase 3 clincial trial for medullary thyroid cancer. [internet]. South San Francisco (CA): Exelixis, Inc.; 2011 Oct 24 [accessed 2011 Oct 26]. [3 p]. Available: http://ir.exelixis.com/phoenix.zhtml?c=120923&p=irol-newsArticle&ID=1620247&highlight=.

335. Schoffski P, Elisei R, Muller S, et al. An international, double-blind, randomized, placebo-controlled phase III trial (EXAM) of cabozantinib (XL184) in medullary thyroid carcinoma (MTC) patients (pts) with documented RECIST progression at baseline [abstract no. 5508]. In: Targeting therapeutics for thyroid cancers. American Society of Clinical Oncology (ASCO) annual meeting; 2012 Jun 1-5; Chicago (IL). Also available: http://abstract.asco.org/AbstView_114_94113.html.

336. National Comprehensive Cancer Network (NCCN). NCCN clinical practice guidelines in oncology: thyroid carcinoma. V3.2011 [slide set]. Fort Washington (PA): National Comprehensive Cancer Network (NCCN); 2011 Jul 11. 87 p. Also available: http://www.nccn.org.

337. Expert Commenter 441. (PRI, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS978 - Vandetanib for treatment of metastatic medullary thyroid cancer. 2011 Oct 25 [review date].

338. Expert Commenter 894. (External, Clinical). Horizon Scanning Structured Comment Form. HS978 - Vandetanib for treatment of metastatic medullary thyroid cancer. 2011 Oct 25 [review date].

339. Expert Commenter 993. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS957 - Vandetanib for treatment of metastatic medullary thyroid cancer. 2011 Oct 21 [review date].

340. Expert Commenter 399. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS978 - Vandetanib for treatment of metastatic medullary thyroid cancer. 2011 Oct 26 [review date].

341. Expert Commenter 284. (External, Clinical). Horizon Scanning Structured Comment Form. HS978 - Vandetanib for treatment of metastatic medullary thyroid cancer. 2011 Oct 25 [review date].

342. Expert Commenter 420. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS978 - Vandetanib for treatment of metastatic medullary thyroid cancer. 2011 Oct 25 [review date].

343. Expert Commenter 1016. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS957 - Vandetanib for treatment of metastatic medullary thyroid cancer. 2011 Oct 19 [review date].

344. Expert Commenter 410. (ECRI Institute, Health Devices). Horizon Scanning Structured Comment Form. HS767 - Cabozantinib (XL 184) for treatment of advanced medullary thyroid cancer. 2012 Jan 17 [review date].

345. Expert Commenter 394. (ECRI Institute, Applied Solutions Group). Horizon Scanning Structured Comment Form. HS767 - Cabozantinib (XL 184) for treatment of advanced medullary thyroid cancer. 2012 Jan 17 [review date].

346. Expert Commenter 894. (External, Clinical). Horizon Scanning Structured Comment Form. HS767 - Cabozantinib (XL 184) for treatment of advanced medullary thyroid cancer. 2011 Dec 21 [review date].

347. Expert Commenter 533. (External, Health Systems/Administration). Horizon Scanning Structured Comment Form. HS767 - Cabozantinib (XL 184) for treatment of advanced medullary thyroid cancer. 2012 Jan 24 [review date].

348. Expert Commenter 681. (ECRI Institute, Technology Assessment). Horizon Scanning Structured Comment Form. HS767 - Cabozantinib (XL 184) for treatment of advanced medullary thyroid cancer. 2012 Jan 10 [review date].

349. Expert Commenter 1169. (PRI, Clinical). Horizon Scanning Structured Comment Form. HS767 - Cabozantinib (XL 184) for treatment of advanced medullary thyroid cancer. 2012 Feb 23 [review date].